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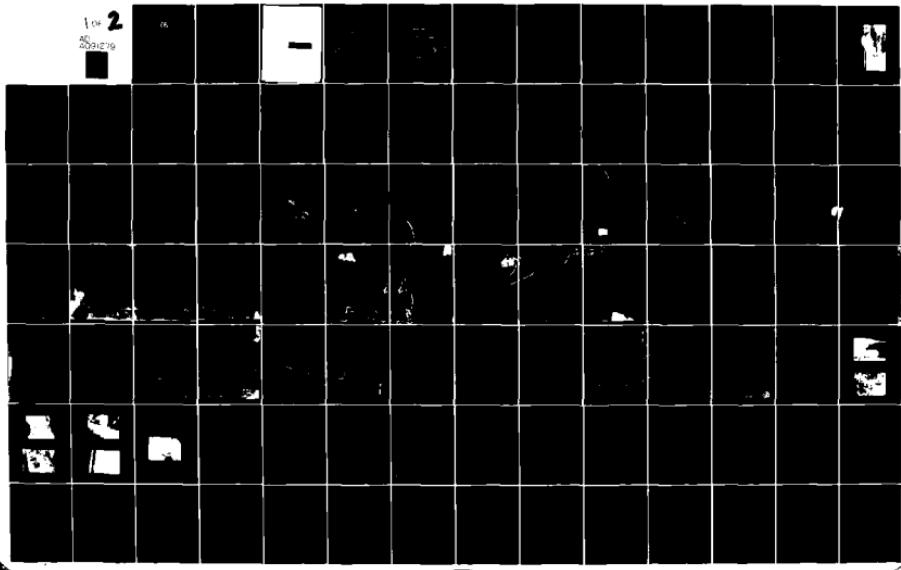
NEW YORK STATE DEPT OF ENVIRONMENTAL CONSERVATION ALBANY F/G 13/13
NATIONAL DAM SAFETY PROGRAM. LAKE WELCH DAM (INVENTORY NUMBER N-ETCII)
SEP 80 E O'BRIEN

DACW51-79-C-0001

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1 of 2
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AD A091279

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
	AD-A091279	
4. TITLE (and Subtitle) Phase I Inspection Report Lake Welch Dam Hudson River Basin, Rockland County, NY Inventory No. 283	5. TYPE OF REPORT & PERIOD COVERED Phase I Inspection Report National Dam Safety Program	
7. AUTHOR(s) Eugene O'Brien	6. PERFORMING ORG. REPORT NUMBER	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Tippetts-Abbett-McCarthy-Stratton 655 Third Avenue New York, NY 10017	8. CONTRACT OR GRANT NUMBER(s) DACW-51-79-C-0001	
11. CONTROLLING OFFICE NAME AND ADDRESS New York State Department of Environmental Conservation 50 Wolf Road Albany, NY 12233	12. REPORT DATE 12 September 1980	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Department of the Army 26 Federal Plaza New York District, CofE New York, NY 10287	13. NUMBER OF PAGES UNCLASSIFIED	
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; Distribution unlimited.	15. SECURITY CLASS. (of this report) ISa. DECLASSIFICATION/DOWNGRADING SCHEDULE	
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) NOV 3 1980		
18. SUPPLEMENTARY NOTES THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DDCI CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety National Dam Safety Program Visual Inspection Hydrology, Structural Stability	Lake Welch Dam Minisceongo Creek Hudson River	
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization. Examination of the available documents and visual inspection of the Lake Welch Dam did not reveal conditions which constitute a hazard to human life or property.		

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Using the Corps of Engineers screening criteria for review of spillway adequacy, it has been determined that concrete gravity section of the dam would be overtopped for all storms exceeding approximately 12 percent of the Probable Maximum Flood (PMF). Although the spillway capacity is inadequate from a hydraulic and hydrologic point of view, the hydraulic inadequacy will not affect the safety of the dam because the concrete dam is supported on the sound rock and overtopping of the dam will cause neither significant erosion at the toe or abutment nor undermine the foundation of the dam. In addition, the stability of the concrete dam section is adequate during overtopping.

The following remedial and maintenance actions should be completed within one year.

- a. Establish a systematic program to observe changes of seepage occurring at the monoliths and the construction joints.
- b. Remove all trees and brush growth on the slopes of the embankment. Provide a program of periodic cutting and mowing of the embankment surfaces.
- c. Provide a program of periodic inspection and maintenance of the dam and appurtenances including yearly operation and lubrication of the reservoir drain. Document this information for future references. Also develop an emergency action plan.

In addition to above remedial and maintenance action the following should be considered:

- a. Resurface the downstream face to the original geometry.
- b. High level outlet made operable.

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HUDSON RIVER BASIN

National Dam Safety Program
LAKE WELCH DAM
(Inventory Number NY283), Hudson River
Basin, ROCKLAND COUNTY, NEW YORK.

PHASE I INSPECTION REPORT,
~~NATIONAL DAM SAFETY PROGRAM~~

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C., 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

Specimen for TESTS	TEST FLOOD	Spillway Capacity	Structural Evaluation	available Codes and/or Special
23	88			A

NATIONAL DAM SAFETY PROGRAM
LAKE WELCH DAM
I.D. NO. N.Y. 283
D.E.C. #196-854
HUDSON RIVER BASIN
ROCKLAND COUNTY, NEW YORK
PHASE I INSPECTION REPORT

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PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam: Lake Welch Dam (I.D. No.N.Y. 283)
State Located: New York
County Located: Orange
Stream: Minisceongo Creek
Basin: Hudson River
Date of Inspection: April 24, 1980

ASSESSMENT

Examination of the available documents and visual inspection of the Lake Welch Dam did not reveal conditions which constitute a hazard to human life or property.

Using the Corps of Engineers screening criteria for review of spillway adequacy, it has been determined that concrete gravity section of the dam would be overtopped for all storms exceeding approximately 12 percent of the Probable Maximum Flood (PMF). Although the spillway capacity is inadequate from a hydraulic and hydrologic point of view, the hydraulic inadequacy will not affect the safety of the dam because the concrete dam is supported on the sound rock and overtopping of the dam will cause neither significant erosion at the toe or abutment nor undermine the foundation of the dam. In addition, the stability of the concrete dam section is adequate during overtopping.

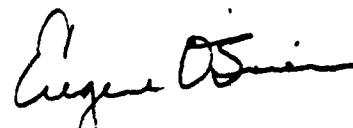
The following remedial and maintenance actions should be completed within one year.

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- b. Remove all trees and brush growth on the slopes of the embankment. Provide a program of periodic cutting and mowing of the embankment surfaces.

- c. Provide a program of periodic inspection and maintenance of the dam and appurtenances including yearly operation and lubrication of the reservoir drain. Document this information for future references. Also develop an emergency action plan.

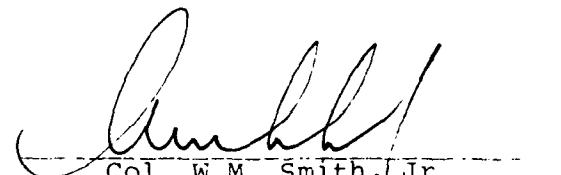
In addition to above remedial and maintenance action the following should be considered:

- a. Resurface the downstream face to the original geometry.
- b. High level outlet made operable.



Eugene O'Brien, P.E.
New York No. 29823

Approved by:



Col. W.M. Smith, Jr.
New York District Engineer

Date:

12 Sep 80

1. OVERVIEW OF DAM



PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE WELCH DAM
I.D. NO. N.Y. 283
DEC #196-854
HUDSON RIVER BASIN
ROCKLAND COUNTY, NEW YORK

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

The Phase I inspection reported herein was authorized by the State of New York, Department of Environmental Conservation by a letter dated 7 January 1980, in fulfilment of the requirements of the National Dam Inspection, Public Law 92-367, 8 August 1972.

b. Purpose of Inspection

This inspection was conducted to evaluate the existing conditions of the dam, to identify deficiencies and hazardous conditions, to determine if these deficiencies constitute hazards to life and property, and to recommend remedial measures where required.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenant Structures

Lake Welch Dam, formerly known as Beaver Pond Dam is located on the east side of Lake Welch. The maximum height of dam is 32 feet. The dam is 788 feet long and consists of a concrete gravity section (563 feet) and an earth embankment (right of gravity section) with a central concrete core wall (225 feet). The concrete dam, supported on a rock foundation consists of 18 monoliths which are anchored to the rock by 25-ton post-tensioned rock anchors. According to available drawings the rock anchors are spaced along the crest 10 feet center to center and are embedded 10 feet into rock. (See drawings given in the Appendix A). The gravity section has a maximum height of 32 feet and a crest width of 3.5 feet. The upstream slope is vertical and downstream slope is 1.6V to 1H. The concrete includes a 152 foot-long spillway portion, the crest of which is one foot below the top of the dam.

The earth embankment at the left side of the concrete dam is about 10 feet wide at the crest and has a maximum height of 19 feet. The upstream slope is about 1V on 2.5H and covered with riprap. The downstream slope is 1V on 3H. A central corewall extends 2 feet from dam crest to the rock, and is about 1.6 feet wide at the top. The slope of the upstream face of the wall is vertical; the downstream face is battered downstream at 4V on 1H from the top of wall to a depth of about 6 feet, and vertical to the remainder of the depth.

There are two regulating outlet pipes located through the concrete dam. The high level outlet is a 12 inch diameter cast iron pipe which discharges water from a square concrete intake structure located at the upstream face of the concrete section, about 210 feet from the left abutment. Water discharges from the reservoir into the intake structure over two 3.3-foot long by 4-inch wide slot openings, located on two walls of the structure. The sill of the openings is at El. 1010, about 6 feet below the top of the concrete dam. Discharge through the pipe may be controlled by a gate valve which is operated from the top of the structure. According to available documents, the outlet once served as a service spillway maintaining the pool at El. 1010 during low flows.

The low level outlet is a 3-foot square sluiceway located through the concrete dam, about 180 feet from the left abutment. Discharge through the sluiceway is controlled by a manually operated sluice gate located at the upstream face of the dam, the control of which is located at the crest of the dam.

The two outlets and the spillway discharge into the natural channel of Minisceongo Creek.

b. Location

The dam is located within the Palisades Interstate Park, Harriman Section, about 2 miles west of the Town of Willow Grove, in Rockland County, New York.

c. Size Classification

The dam is 32 feet high, and has a lake storage capacity of 4,750 acre-feet (1,000 and to 50,000 acre-feet). Therefore, the dam is classified as "Intermediate".

d. Hazard Classification

The dam is in the high hazard potential category because a campsite, several homes along the creek and in the Town of Willow Grove, state Route 210 and the Palisades Interstate Parkway are all located within 1.5 miles downstream from the dam.

e. Ownership

Lake Welch Dam is owned, operated and maintained by the Palisades Interstate Park Commission of the New York State Department of Parks and Recreation, Administration Building, Bear Mountain, New York 10911, Tel. No. (914) 786-2701.

f. Purpose of Dam

The impoundment provided by the dam is used mainly for recreation. This lake also supplies water via pipelines to campsites at the lake.

g. Design and Construction History

Original design and construction records are not available. It is reported the construction of the dam was completed in 1937. The designer of the original dam was Mr. W.A.Welch, Chief Engineer, Palisades Park Commission. The name of the Contractor is unknown. The concrete dam was rehabilitated in 1959 and 1979. Because of leakage the entire concrete dam was resurfaced in 1959 by applying a 3-inch "gunite" layer. In 1979, the concrete dam was again repaired because of leakage problems; in addition, the stability of the dam was improved. According to available documents, the entire concrete dam was strengthened by installing post-tensioned rock anchors from the crest of dam into the foundation. The post-tensioned rock anchors were installed and grouted in drill holes spaced at 10 feet center to center along the crest. Additional holes were drilled through the dam from the crest and pressure grouted. The design and supervision of the repairs were carried out by the engineering firm of Charles T. Main, Boston. In addition, the existing gunite surface of the downstream face was partially removed and the original concrete exposed in preparation for re-surfacing later this year.

h. Normal Operating Procedure

The USGS map and available drawings show that the normal pool level once was maintained at El 1010, the level of the sill at the high level regulating outlet. Since the high level outlet pipe is now inoperative and the gate in the closed position, the lake level is maintained at the crest of the ungated principal spillway, El. 1015, about 1.3 feet below the top of the concrete dam.

1.3

PERTINENT DATA

a.	<u>Drainage Area</u> (sq.miles)	2.87
b.	<u>Discharge at Damsite</u> (cfs)	
	Principal spillway, Top of dam (El. 1016.3)	591
	Sluiceway, Top of dam (El. 1016.3)	250
	12-inch CI outlet pipe	Inoperative
c.	<u>Elevation</u> (feet above MSL)	
	Top of dam (concrete dam)	1016.3
	Top of dam (earth dam)	1019.0
	Principal spillway crest	1015.0
	Sluiceway invert	984
d.	<u>Reservoir</u>	
	Length of normal pool (miles)	0.6
	Surface area (acres)	218
e.	<u>Storage</u> (acre-feet)	
	Top of principal spillway crest	4450
	Top of dam	4750
f.	<u>Dam</u>	
	Type:	concrete gravity and earth embankment
	Length (ft):	concrete-563; embankment-225
	Height (ft):	concrete- 32; embankment- 19
	Crest width (ft):	concrete-3.6;embankment-10
	Side Slopes: upstream - concrete-vertical;	
		embankment-1V on 3H
	downstream - concrete-1.6V on 1H	
		embankment-1V on 2.5H
	Impervious core:	embankment - concrete wall
	Concrete wall (top width - ft):	embankment-1.5 ft
	Side slopes: upstream - vertical	
		downstream-4V on 1H (up to 6.0 ft
		from top of wall and
		vertical to rock
		foundation)
g.	<u>Spillway</u>	
	Type:	Broad-crested,concrete
	Length (ft):	152
	Crest Elevation (ft):	1015.0

h. Regulating Outlets

Type: High level - 12-inch diameter
 CI pipe
Low level - 3 foot square
 concrete sluiceway
Elevation (ft): (High level)-intake - 1010
 outlet - 984
 (Low level) -intake - 991.5
 outlet - 984-

SECTION 2 - ENGINEERING DATA

2.1 GEOLOGY

Lake Welch Dam is located in the New England Upland physiographic province of New York State. These uplands, with relief ranging from 500 to 1,300 feet above sea level, trend northeast-southwest; folds striking northeasterly and plunging slightly to the north are characteristic of the province. Fault lines throughout the New England uplands are generally parallel to the strike of the rocks. Bedrock in the vicinity of Lake Welch includes crystalline metasedimentary hornblende gneisses and leucogranitic gneisses of Precambrian Age.

2.2 SUBSURFACE INVESTIGATION

No subsurface investigation could be located for the project. However, the "General Soil Map of New York State" prepared by the Cornell University Experiment Station (1963) indicates that the surficial soils around Lake Welch Dam are of the Rockland-Chatfield Association. The Rockland, about 70% of the area, is steep slopes, gneiss rock outcrop with shallow, stony soil developed from glacial till. The remaining area is predominantly Chatfield soils that are moderately deep (less than 30 inches to bedrock), very stony and well drained, developed from glacial till derived from gneiss.

2.3 DESIGN RECORDS

The original dam was designed by Mr. W.A. Welch, Chief Engineer of the Palisades Interstate Park Commission. The dam is reported built in 1937. There are no design data or specific design memoranda available for the project features. Two contract drawings dated February 1928 were obtained from the New York State Department of Environmental Conservation and are given in Appendix A. The drawings show the plan, profile and details of the dam.

The concrete dam was resurfaced in 1959 by applying a 3 inch thick quinque surface. The details of modifications are shown on a drawing entitled "Details of Dam Repairs" dated July 17, 1958, prepared by the Palisades Interstate Park Commission and given in Appendix A.

Because of excessive seepage at the concrete dam, major modifications were made in 1979 in accordance with recommendations by Charles T. Main, Consulting Engineers, Boston, Massachusetts. The recommendations included chemical and cement grouting to control seepage through horizontal and construction joints and strengthening of the dam by installing rock anchors. The details of the modifications, shown on a construction drawing entitled "Lake Welch Dam Repairs", dated April 4, 1978 and prepared by Charles T. Main, Inc., Boston, Massachusetts, are given in the Appendix A.

2.4 CONSTRUCTION RECORDS

No detailed construction records of the original dam and the subsequent modifications are available; however, photographs and daily narratives of the 1979 repairs are available.

2.5 OPERATION RECORDS

There is no formal operation and maintenance manual for the project. There are no records of rainfall and operation of the gates and the sluiceways.

2.6 EVALUATION OF DATA

Existing information was made available by the New York State Department of Environmental Conservation, Albany, New York, and the owner.

The information obtained from the available data, the personal interviews and the visual inspection are considered adequate for the Phase I inspection and evaluation. Reviews of the original and subsequent drawings indicate some discrepancies, as follow:

- a. Crest elevation of the concrete dam is incorrectly shown on 1978 repair drawings.
- b. The length of spillway shown on the original drawing shows about 89.5 feet, whereas repair drawings of 1978 show about 152 feet. There are no construction records of the spillway modifications available; however, the spillway length of 152 feet was confirmed during the inspection.
- c. Geometry of the downstream face of the dam is in accordance with 1978 repair drawings and not as shown on the 1929 drawings.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

The visual inspection of the Lake Welch Dam was made on 24 April 1980. The weather was sunny with the temperature at about 60° F. The reservoir level was El.1015.4 at the time of inspection, about 3 inches above spillway crest.

b. Dam

(i) The Gravity Section Including Spillway:

The concrete gravity section appears to be in generally good condition. The horizontal and vertical alignment are uniform and there is no indication of movement. The crest and the upstream face above the waterline appears to be in good condition. At the crest there are grouted holes which were drilled during the recent repairs.

The gunite surface at the downstream face of the dam has been removed and the original concrete exposed. The exposed concrete surface appears in good condition. There is minor seepage through several construction and monolith joints. Several construction joints are packed with oakum to prevent seepage.

(ii) Embankment: The earth embankment appears to be in generally good condition. The horizontal and vertical alignment of the crest are uniform.

The downstream slope does not exhibit any evidence of subsidence, erosion and sloughing. The slope is covered with ground cover, seedlings, shrubs and trees. There are no signs of seepage at the slope, toe and downstream from the toe. There is heavy vegetation, including large trees, downstream of the toe area.

The upstream slope does not show any sloughing or erosion. The slope is covered with ground cover and shrubs and trees.

c. Appurtenant Structure

The concrete surface of the low level sluiceway is in good condition. The physical condition of the downstream face of the sluice gate appears in good condition except for minor rusting. Although the gate is closed there is minor discharge emerging from the sluiceway. The operating control for the gates located at the crest appears to be in good condition. The gate was not operated during the inspection because

the owner's representative did not have the keys for a padlock; the owner reports that the gate is in operating condition.

The 12-inch cast iron outlet pipe is closed and reported to be inoperable. However, there was discharge of about 1 cfs through the pipe.

d. Downstream Channel

The channel downstream of the concrete dam is Minisceongo Creek. In the vicinity of the dam, the channel floor and the side slopes are in rock. There is some vegetation including bushes and large trees, which will not impede flows over the spillway.

e. Reservoir Area

In the vicinity upstream of the dam there was no evidence of sloughing, potentially unstable slopes, or other unusual conditions which would adversely affect the dam.

3.2 EVALUATION OF OBSERVATIONS

Visual observation made during the course of the investigation revealed several deficiencies which at present do not adversely affect the adequacy of the dam. However, these deficiencies do require attention and should be corrected.

The following is a summary of the problem areas encountered, in order of importance, with the appropriate recommended action:

1. Establish a systematic program to observe and monitor changes in seepage occurring at the monoliths and construction joints.
2. Remove all trees and brush growth on the slopes of the embankment. Provide a program of periodic cutting and mowing of the embankment surfaces.
3. Provide a program of periodic inspection and maintenance of the dam and appurtenances including yearly operation and lubrication of the reservoir drain. Document this information for future references. Also develop an emergency action plan.

In addition to above remedial and maintenance the following should be considered:

- a. Resurface the downstream face to the original geometry.
- b. High level outlet made operable.

SECTION 4 - OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 PROCEDURES

There is no specified required release of water from the lake. The lake level is maintained at the principal spillway crest level the entire year. The low level outlet which is a 3-foot square sluiceway, is usually kept closed. The 12-inch diameter cast iron pipe is closed and reported inoperative.

4.2 MAINTENANCE OF THE DAM

The dam is maintained by the owner, Palisades Interstate Park Commission. Maintenance of the dam is considered inadequate as evidenced by the seepage through the monolith joints; at the concrete section there is extensive vegetative growth on the earth embankment and an inoperable regulation gate at the high level outlet.

4.3 WARNING SYSTEM IN EFFECT

There is no warning system in effect or in preparation.

4.4 EVALUATION

The dam and appurtenances have not been maintained in satisfactory condition as noted in Section 3: Visual Inspection.

SECTION 5 - HYDROLOGIC/HYDRAULIC

5.1 DRAINAGE BASIN CHARACTERISTICS

Lake Welch Dam is located about 2 miles west of Willow Grove in Rockland County, New York. The total drainage area contributing to the lake is 2.87 square miles of which the lake occupies 234 acres or 13% of the area. The basin is a part of the Palisades Interstate Park and is mainly undeveloped except for a few campsites. Relief in the drainage area is fairly steep, varying from E. 1015 (lake surface) to ridges above El 1200.

5.2 ANALYSIS OF CRITERIA

The analysis of Lake Welch Dam was performed using the U.S. Army Corps of Engineers HEC-1 computer program ^{1/}. The Probable Maximum Precipitation (PMP) was obtained from Hydro-meteorological Report No. 51 ^{4/}. The unit hydrograph was computed using the Snyder method ^{6/} and average regional coefficients were 2 and 400 for Ct and 640 Cp, respectively. It was assumed that there would be an initial rainfall loss of 2 inches and that the constant loss rate would be 0.5 inches per hour. It was also assumed that both outlets were closed during the flood event. In accordance with the recommended guidelines of the Corps of Engineers ^{7/}, the adequacy of the spillway was analyzed using the Probable Maximum Flood (PMF) and one-half the PMF.

5.3 SPILLWAY CAPACITY

The principal spillway is located at the concrete dam. The length of spillway is about 152 feet with a 3.5-foot wide concrete sill at El 1015. The maximum discharge capacity of the principal spillway is 591 cfs.

5.4 RESERVOIR CAPACITY

Normal capacity of Lake Welch at El 1010 (equivalent to the intake elevation of high level outlet) is reported to be about 3440 acre-feet ^{7/}. The computed storage between El 1010 and El 1015 (principal spillway crest) is about 1010 acre-feet. Total reservoir capacity to the top of the concrete dam (El 1016.3) is about 4750 acre-feet. The available surcharge storage between the spillway crest and the top of the dam is about 291 acre-feet which is equivalent to about 1.9 inches of runoff over the entire basin.

5.5 FLOODS OF RECORD

There are no available records of floods or maximum lake elevations.

5.6 OVERTOPPING POTENTIAL

The potential of the dam being overtopped was investigated on the basis of the spillway discharge capacity and the available surcharge storage to meet the selected design flood inflows.

The Probable Maximum Flood routed through the lake caused the lake surface to rise to El 1018.41, 2.11 feet above the concrete dam, but does not overtop the embankment (El 1019.0). The one-half Probable Maximum Flood routed through the lake caused the lake surface to rise to El 1017.41, 1.11 feet above the concrete dam. The peak outflow discharge was 4765 cfs.

Using the Corps of Engineers criteria, the maximum spillway capacity without overtopping the dam is 12% of PMF outflow.

5.7 EVALUATION

The dam does not have sufficient spillway capacity to pass either the PMF or one-half the PMF without overtopping the dam. On the basis of this investigation the project discharge capacity is considered to be inadequate from a hydrologic and hydraulic point of view; however, overtopping of the dam under the PMF would cause neither significant erosion at the toe or abutment nor undermine the foundation of the dam.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Visual observations did not indicate condition which would adversely affect the structural stability of the dam. The observed seepage through the monolith and construction joints of the concrete dam are not detrimental to the dam's stability or safety at the present time.

b. Design and Construction Data

The original preconstruction design computations regarding the structural stability of the dam or spillway are not available. Stability analysis of the concrete dam with the rock anchors was carried out by Charles T. Main, Inc., Consulting Engineers, Boston, Massachusetts, for the 1979 rehabilitation program; these are given in the Appendix F.

c. Operating Records

There are no available records of reservoir elevation and gate operation. No major operational problems which would affect the stability of the dam were reported.

d. Post Construction Changes

The concrete dam was resurfaced in 1959 by applying a 3 inch thick gunite surface. The details of modifications are shown on a drawing entitled "Details of Dam Repairs" dated July 17, 1958, prepared by the Palisades Interstate Park Commission and given in Appendix A.

Because of excessive seepage the concrete dam, major modifications were made in 1979 in accordance with recommendations by Charles T. Main, Consulting Engineers, Boston, Massachusetts. The recommendations included chemical and cement grouting to control seepage through horizontal and construction joints and strengthening of the dam by installing rock anchors. The details of the modifications, shown on a construction drawing entitled "Lake Welch Dam Repairs", dated April 4, 1978 and prepared by Charles T. Main, Inc., Boston, Massachusetts, are given in the Appendix A.

e. Seismic Stability

According to the recommended Corps guidelines, the dam is located in Seismic Zone No.1. However, based on past earthquake history, the New York State Geological Survey

considers the site to be in Zone 2. Based on this assessment the dam is considered in the Seismic Zone 2. The results of Seismic Stability are described in Section 6.2.

6.2 STRUCTURAL STABILITY ANALYSIS

The available structural stability analysis of the non-overflow section of the concrete dam was reviewed. The method of analysis and stability criteria, except the values of sliding coefficients, were computed in accordance with EM 1110-2-2200 published by the Corps of Engineers, U.S. Army. The sliding coefficient values used were higher than recommended. The spacing of rock anchors used in the structural stability analysis is not the same as that shown on 1978 construction drawings. The analysis shows that rock anchors at the gravity section are spaced 5 feet center to center, whereas the 1978 drawings show a 10-foot spacing. The owner was unable to verify the discrepancy. Since a 10-foot spacing of the rockbolts at the gravity section would be more critical, additional analyses of structural stability using this anchor spacing were performed. These are included in the Appendix E, and summarized as follows:

<u>Loading Condition</u>	<u>Location of Resultant</u>	<u>Sliding F.S. (see Appendix E)</u>
a. Normal loading condition, reservoir level at spillway crest, no ice load	Within middle third	1.53
b. Normal loading condition, reservoir level at spillway crest, with ice load	-3.09 feet outside middle third	1.30
c. Unusual loading: flood level equal to 1/2 PMF at gravity section	Within middle half	1.17
d. Extreme loading: flood level equal to PMF at the gravity section	Within middle half	1.06
e. Unusual loading: reservoir level at spillway crest, and earthquake forces	Within the middle half	1.30

The results of the stability analysis indicate that stability of the gravity section of the dam against overturning is inadequate for all loading conditions except normal loading.

The analysis indicates that in order for the resultant of the force to be within the middle third under the other loading cases, the rock bolts would have to be stressed 30.5 tons, which is above the working load(25 tons) and less than the ultimate limit (37 tons). Because of the additional force (5.5 tons) that can be developed in the anchors, the stability of the gravity section of the dam against overturning is considered adequate. The sliding stability is considered adequate for all cases.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety

Examination of available documents and the visual inspection of the Lake Welch Dam and appurtenant structures did not reveal any conditions which constitute a hazard to human or property. The dam (earth and concrete gravity sections) are not considered to be unsafe.

Using the Corps of Engineers screening criteria for review of spillway adequacy, it has been determined that the concrete gravity dam would be overtopped for all storms exceeding approximately 12 percent of the PMF. Although the spillway capacity is inadequate from a hydraulic and hydrologic point of view, the hydraulic inadequacy will not affect the safety of the dam because the concrete dam is supported on sound rock and overtopping of the dam will cause neither significant erosion at the toe or abutment, nor undermine the foundation of the dam. In addition, the concrete dam is stable under all loading conditions.

b. Adequacy of Information

The information and data available were adequate for performance of this investigation.

c. Necessity of Additional Investigations

No additional investigations are required.

d. Urgency

The recommended measures 1 through 3 as described below must be corrected within 1 year from notification.

7.2 RECOMMENDED MEASURES

The following are the recommended measures:

1. Establish a systematic program to observe and monitor changes in seepage occurring at the monoliths and construction joints.
2. Remove all trees and brush growth on the slopes of the embankment. Provide a program of periodic cutting and mowing of the embankment surfaces.

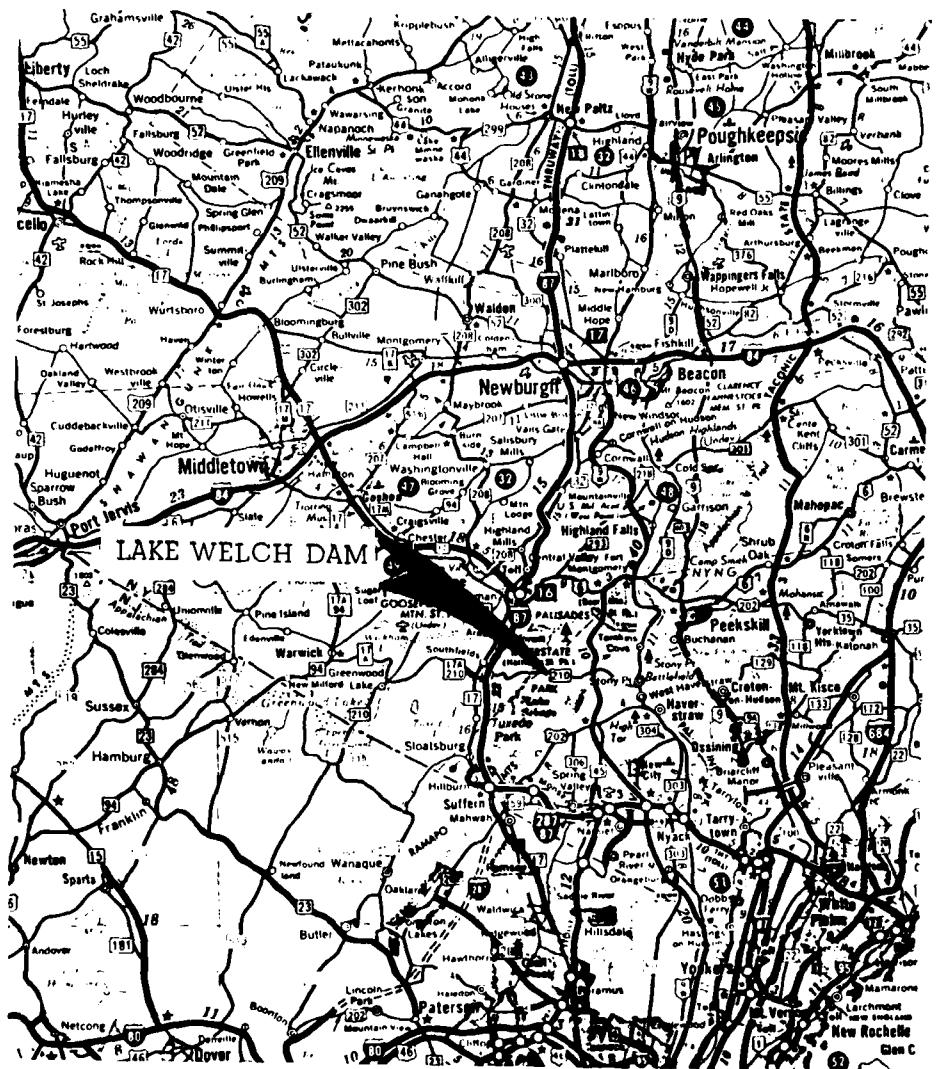
3. Provide a program of periodic inspection and maintenance of the dam and appurtenances including yearly operation and lubrication of the reservoir drain. Document this information for future references. Also develop an emergency action plan.

In addition to above remedial and maintenance, the following should be considered:

- a. Resurface the downstream face to the original geometry.
- b. High level outlet made operable.

DRAWINGS

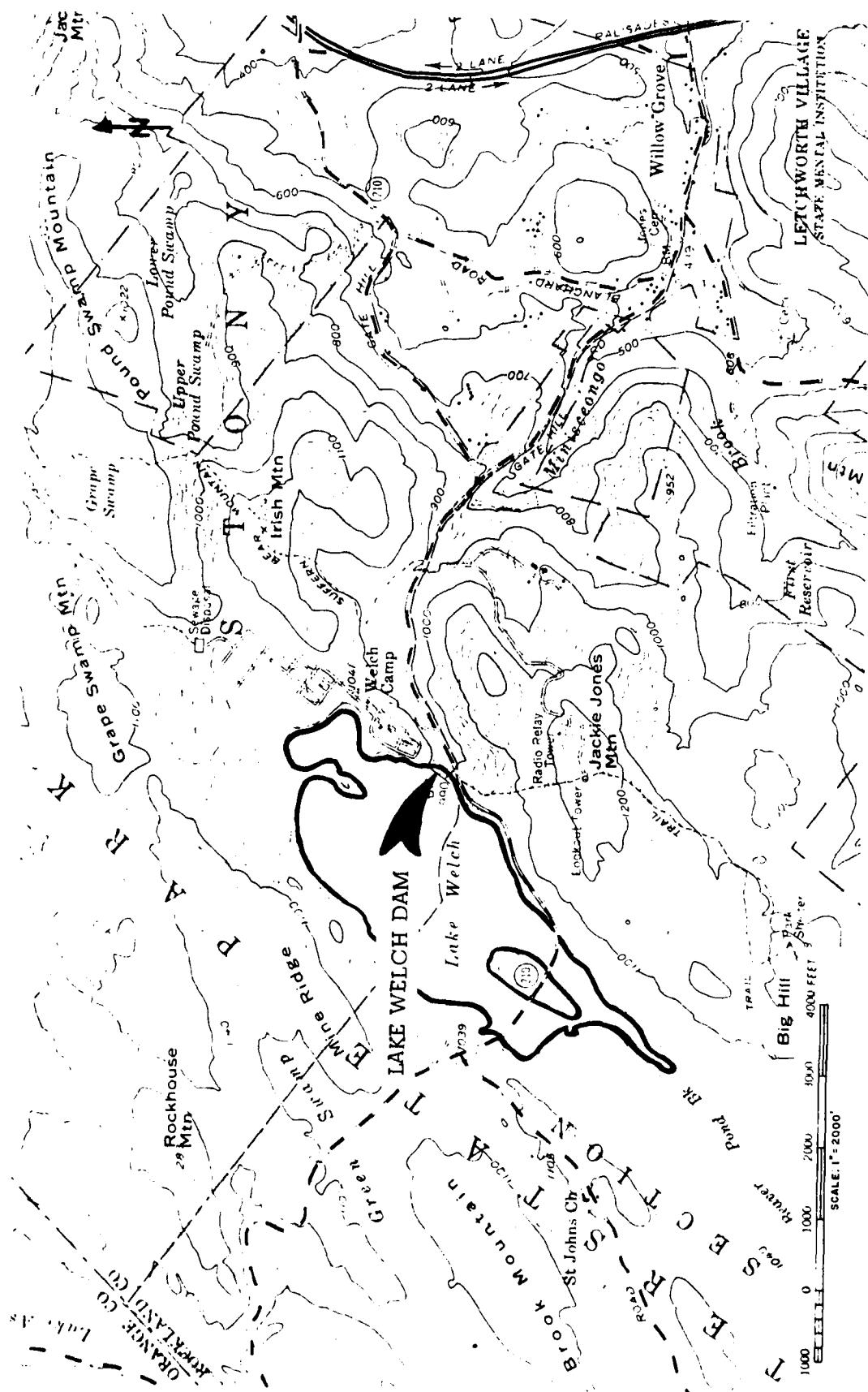
APPENDIX A



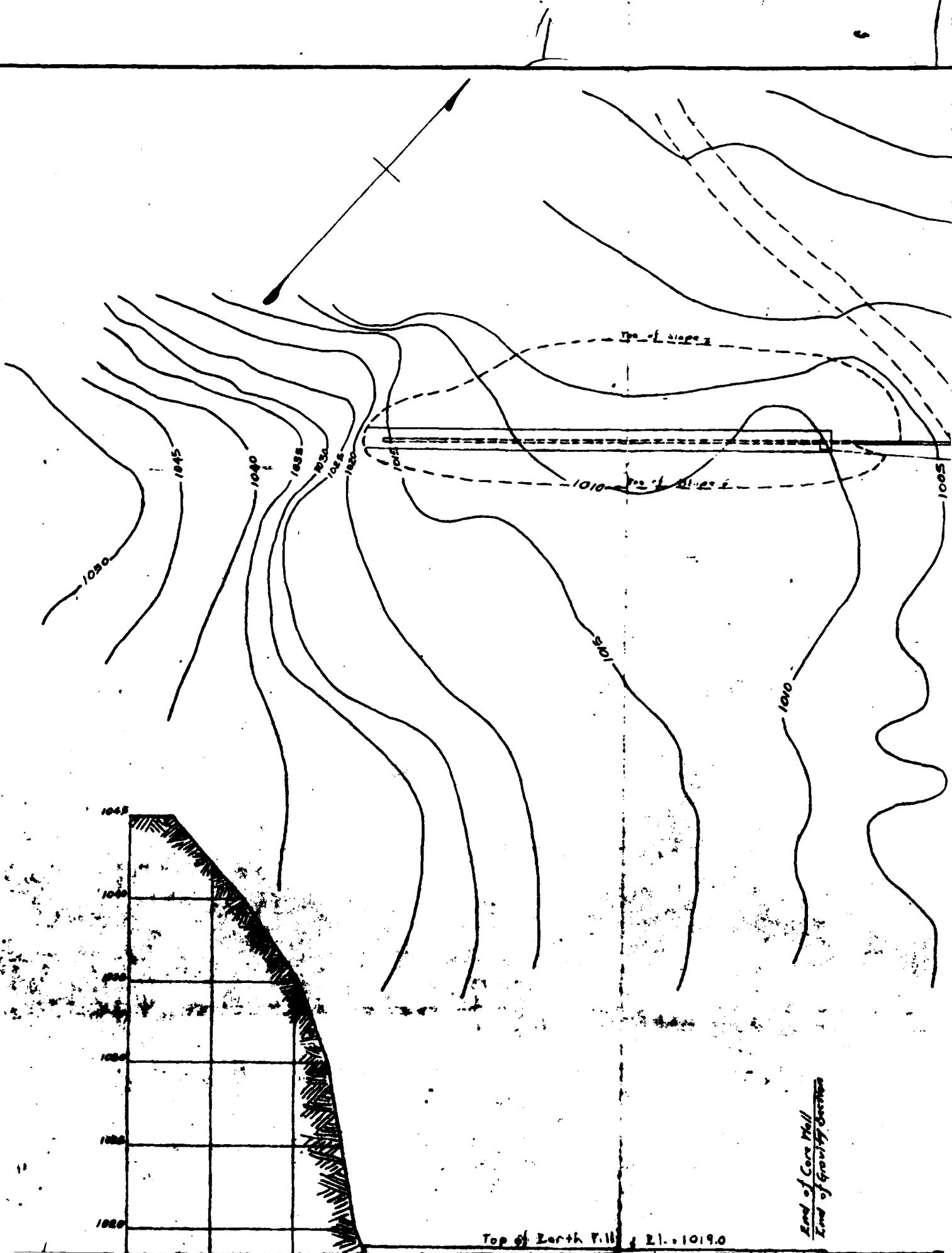
SCALE 1 inch = 11.2 Miles

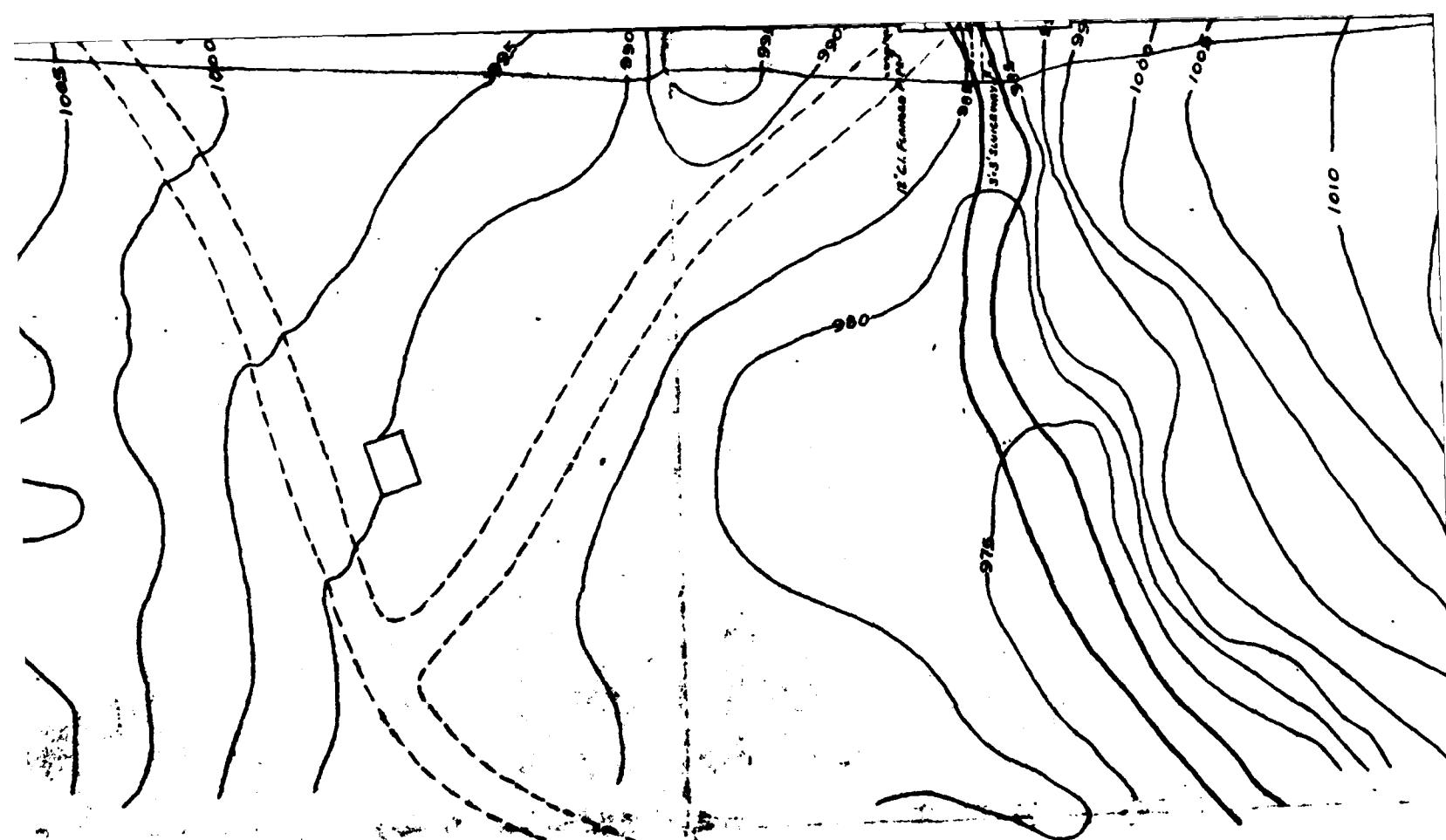
VICINITY MAP
LAKE WELCH DAM

THIELLS QUADRANGLE
NEW YORK



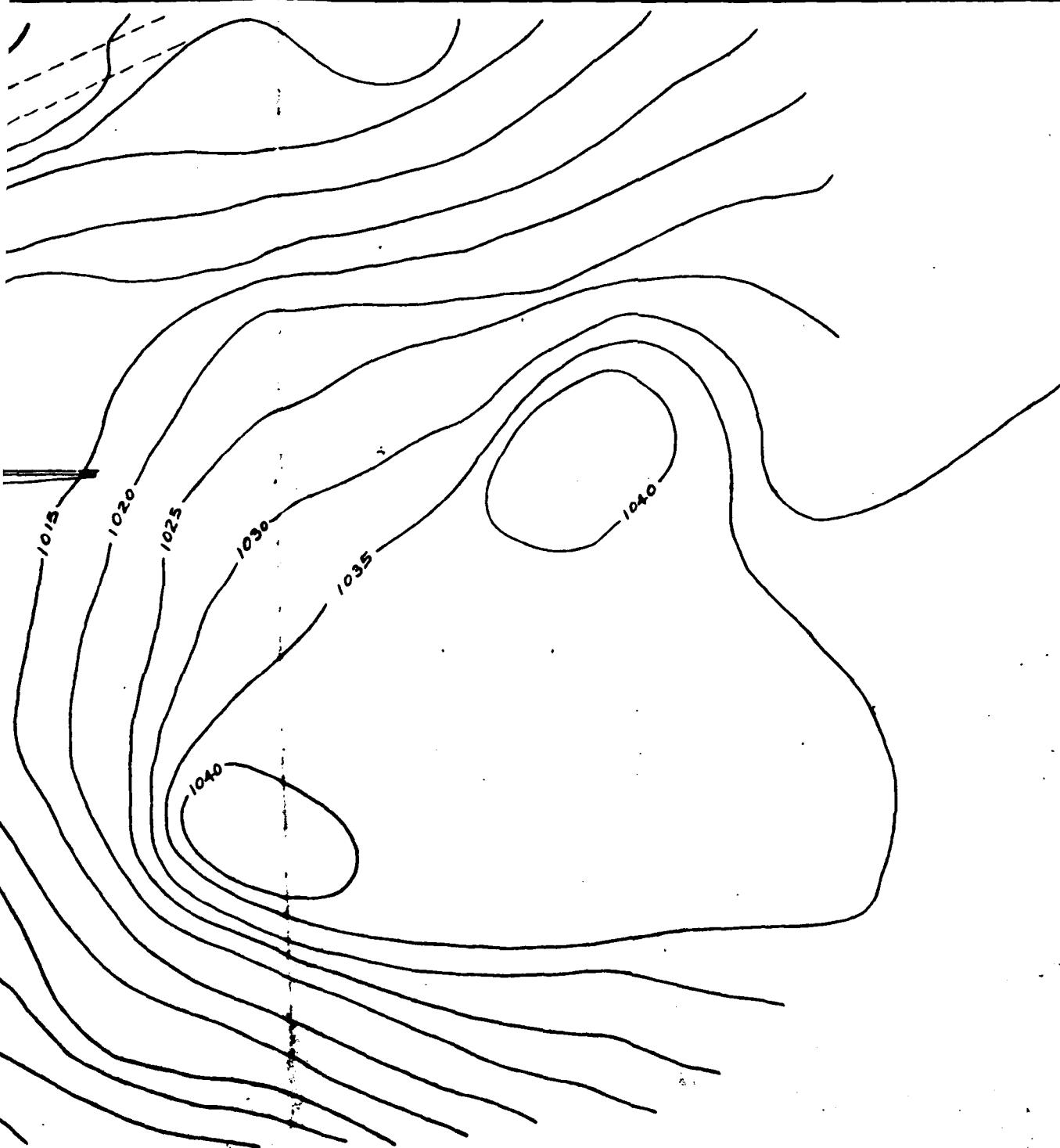
TOPOGRAPHIC MAP
LAKE WELCH DAM





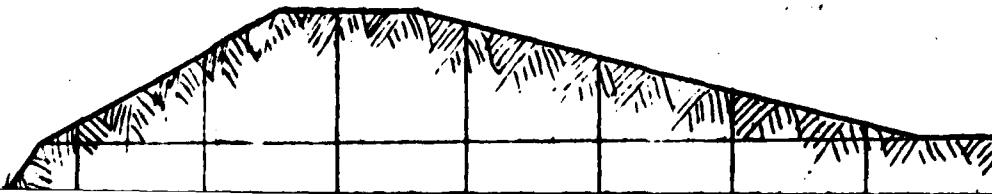
PLAN

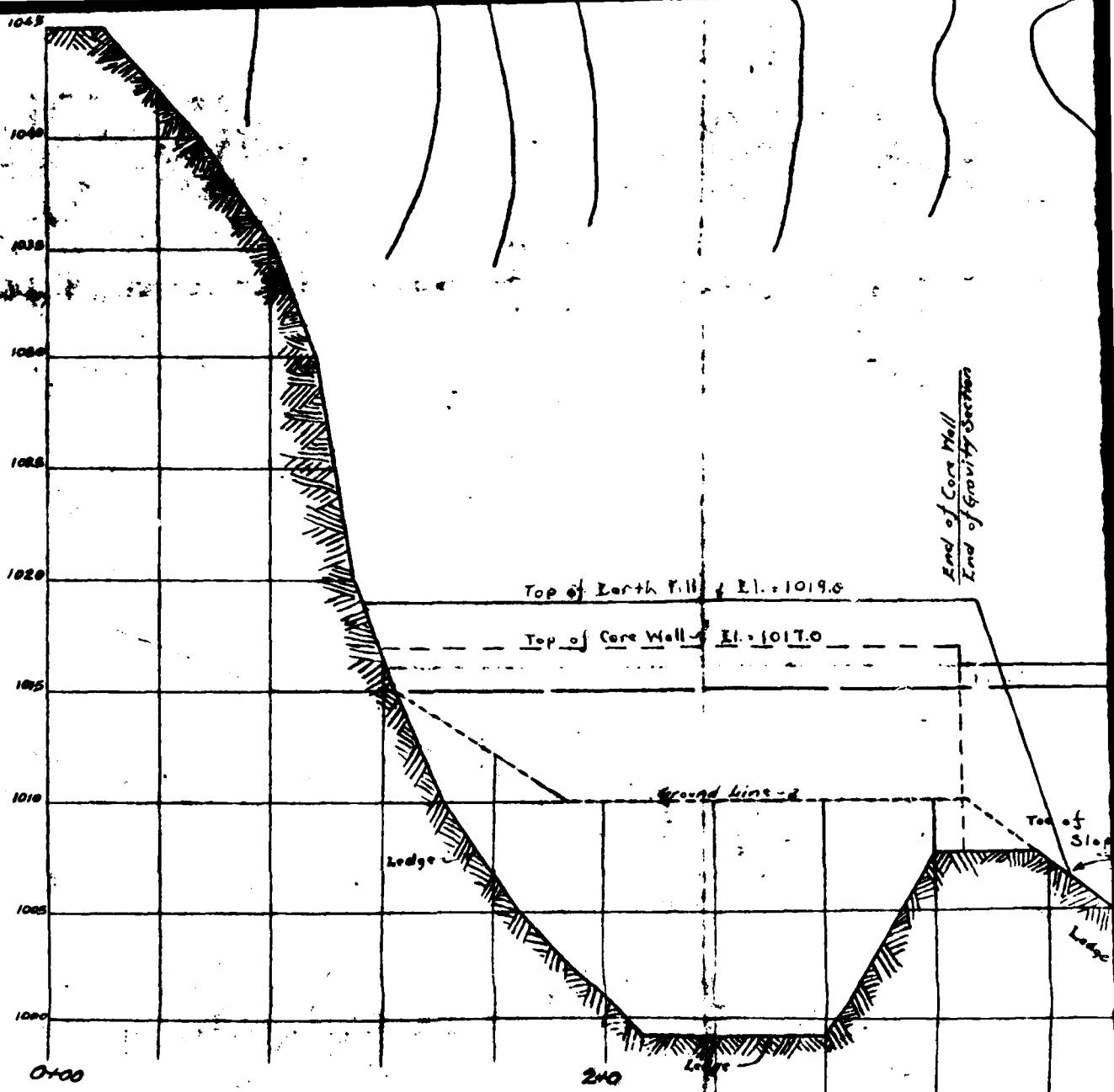
3



Note:

Expansion joints to be
placed every 30'





U.S. DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

STATE PARK EMERGENCY CONSERVATION WORK
NEW YORK STATE PARK NO 26

PALISADES INTERSTATE PARK
TOWN OF STONY POINT ROCKLAND COUNTY NEW YORK

BEAVER POND DAM

SCALE AS SHOWN DECEMBER 1, 1933 PREPARED BY

Recommended for Approval

Approved By:

Approved By: M. S. 10

Approved By:

General Superintendent

Chief Eng. and Genl. Mgr.

District Inspector E.C.W.

District Officer E.C.W.

Y.E. 1933

4

PLAN

Crest of Gravity Section - El. +1016.0
Flow Line E.L. +1016.0

22' 67.5'

PROFILE

Line of Cut Water on West Well

Line of Cut

Top of Footing - El. +983.0

4000

6000

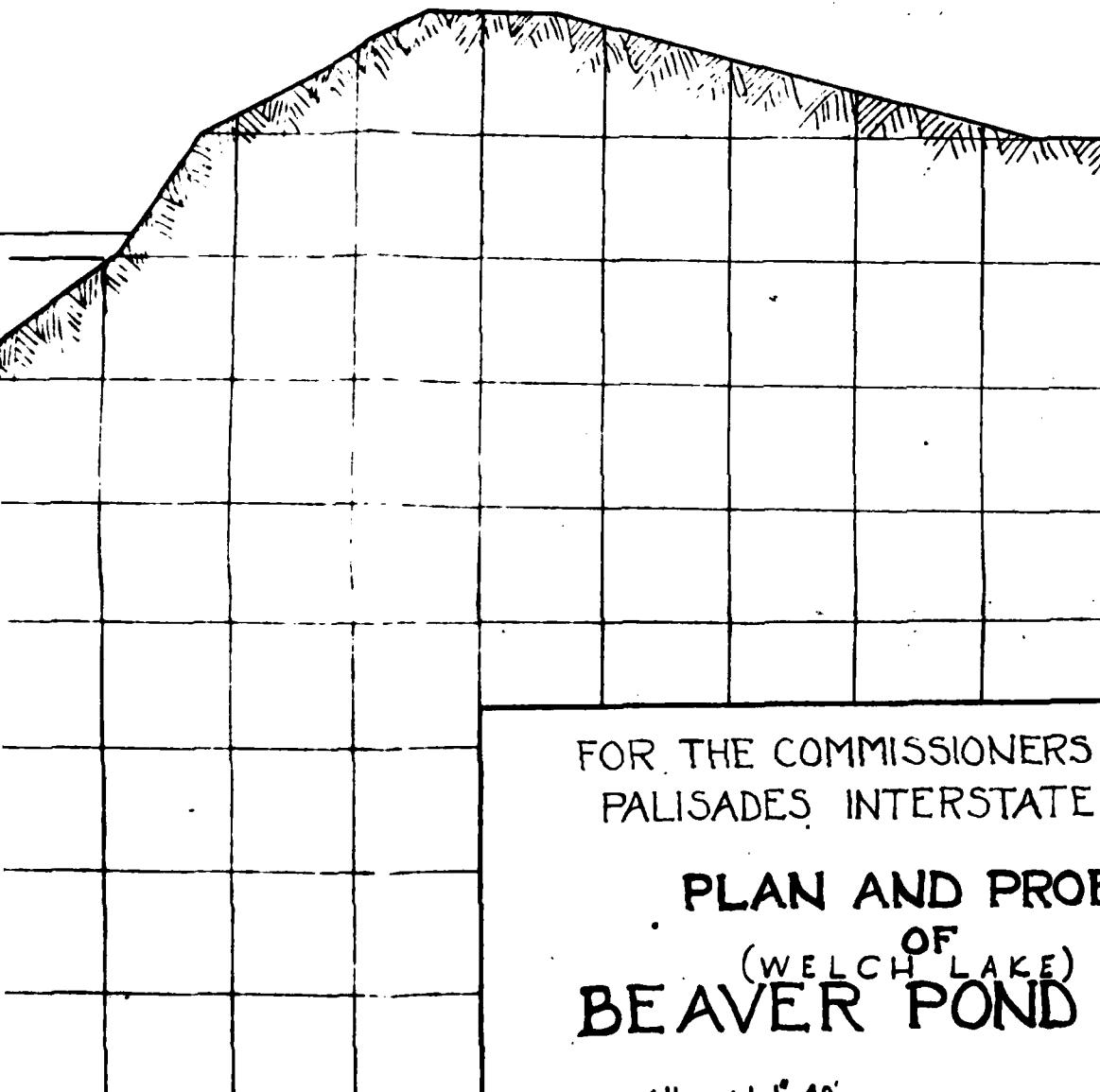
8100

5

+

Note:

Expansion joints to be placed every 30'



FOR THE COMMISSIONERS OF THE
PALISADES INTERSTATE PARK

PLAN AND PROFILE
(WELCH LAKE)
BEAVER POND DAM

Scale - { Horizontal - 1' = 40'
Vertical - 1' = 5'

June 1929
Revised Aug.

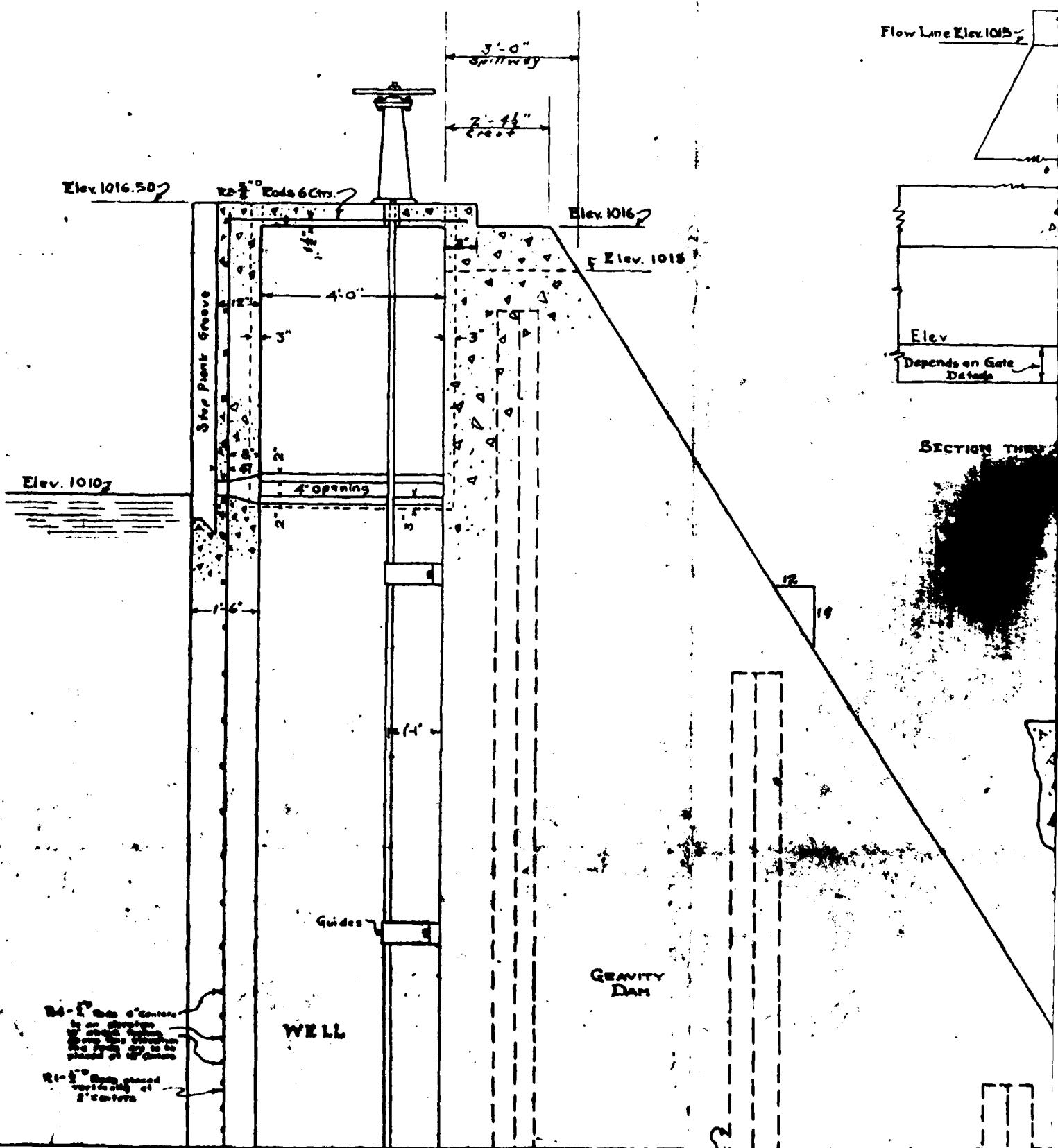
W^m A. Welch
Chief Engineer

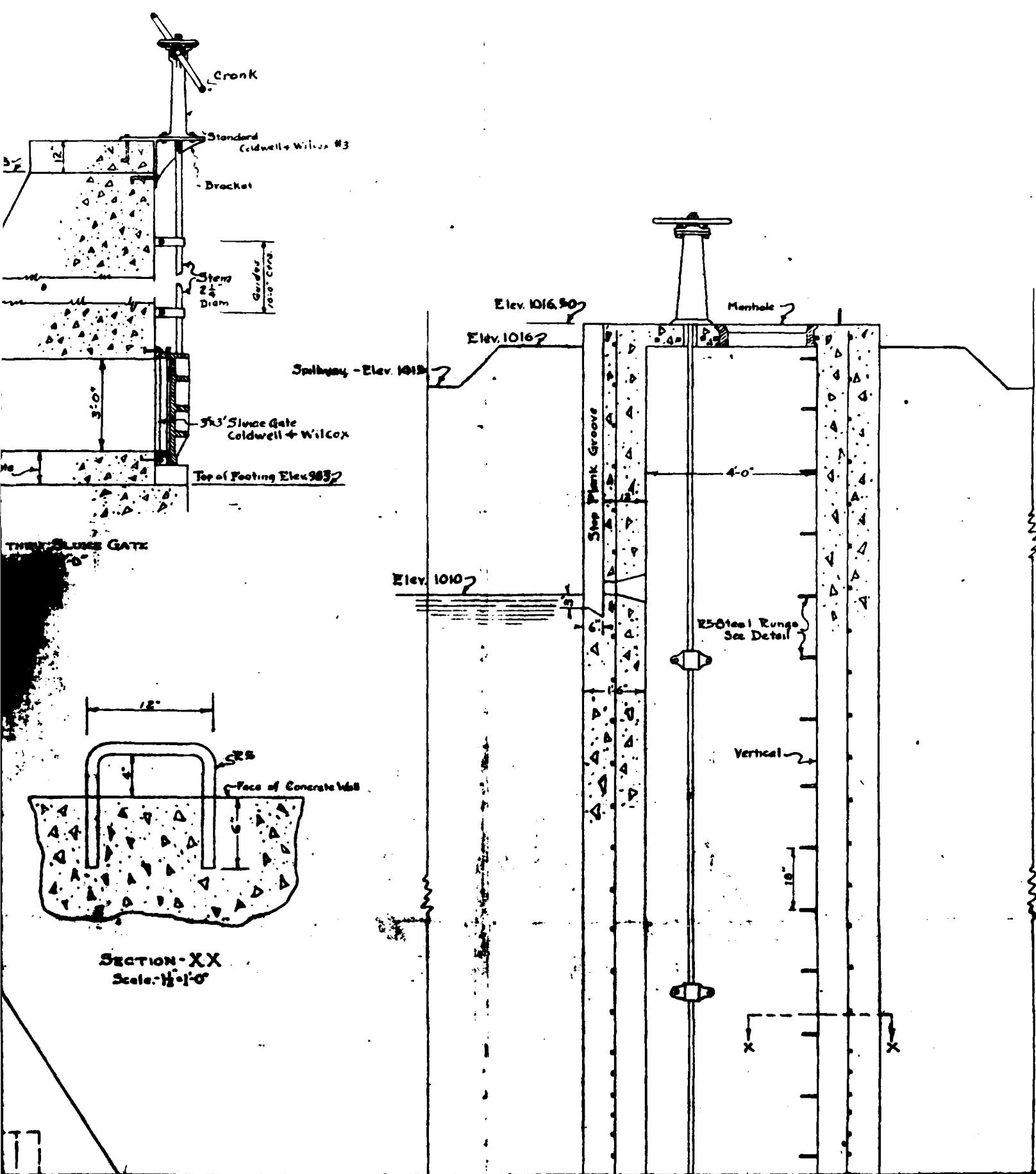
No 858-A
1/2 P5-F8

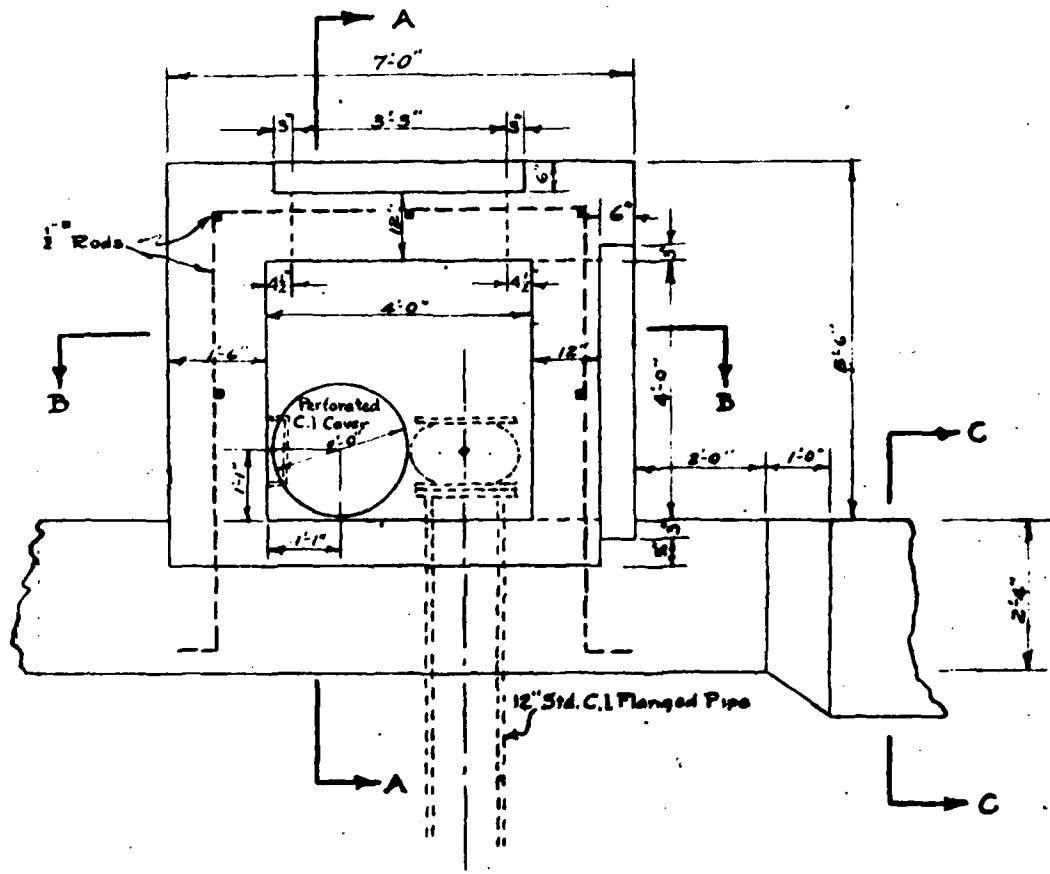
RECORDED
GENERAL CIVIL ENGINEERING
DEPT. OF STATE

6

Rensed print received 10/22/68

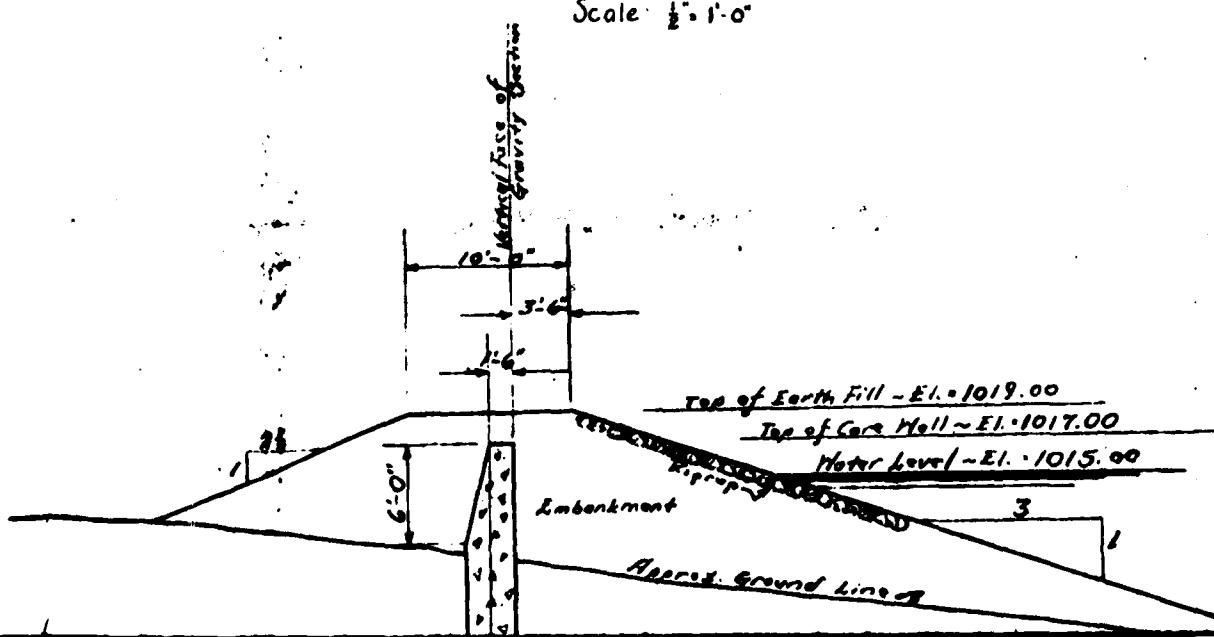






PLAN OF WELL

Scale: $\frac{1}{2} : 1\text{-}0"$



24- $\frac{1}{2}$ " rods 6' centers
at an elevation
12' above footing.
Above this elevation
the rods are to be
placed at 12" centers

Ri- $\frac{1}{2}$ " Rods placed
vertically at
2' centers

Telephone Wire

Guides

WELL

GRAVITY
DAM

Elev 991.507

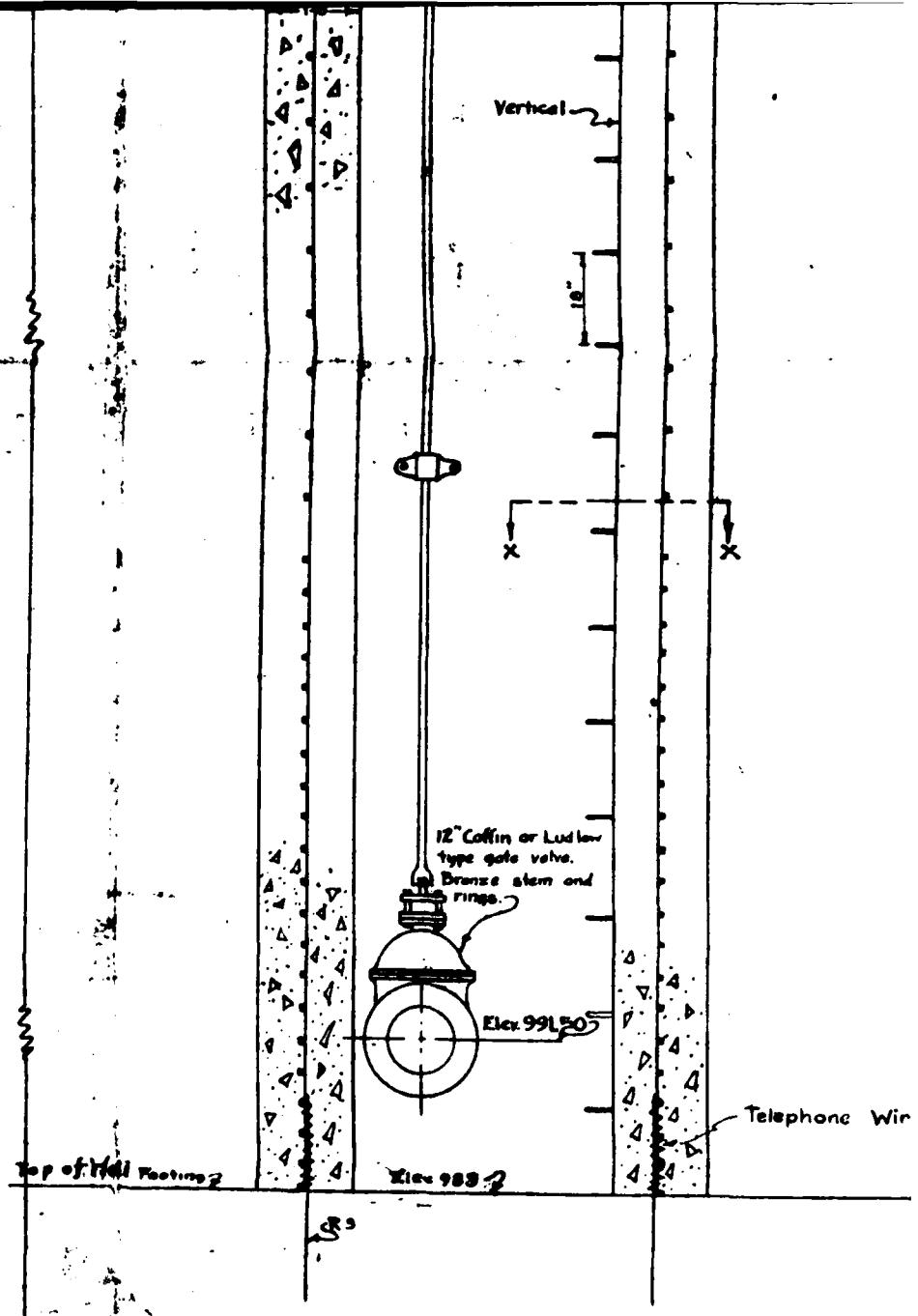
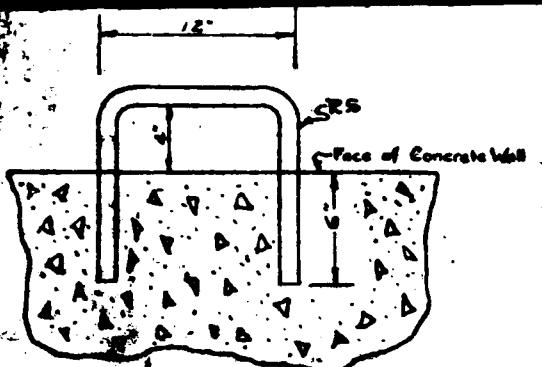
Vertical Key 2

Horizontal Key
Top of footing Elev 9880

SECTION-AA

Scale $\frac{1}{2} : 10'$

SECTION



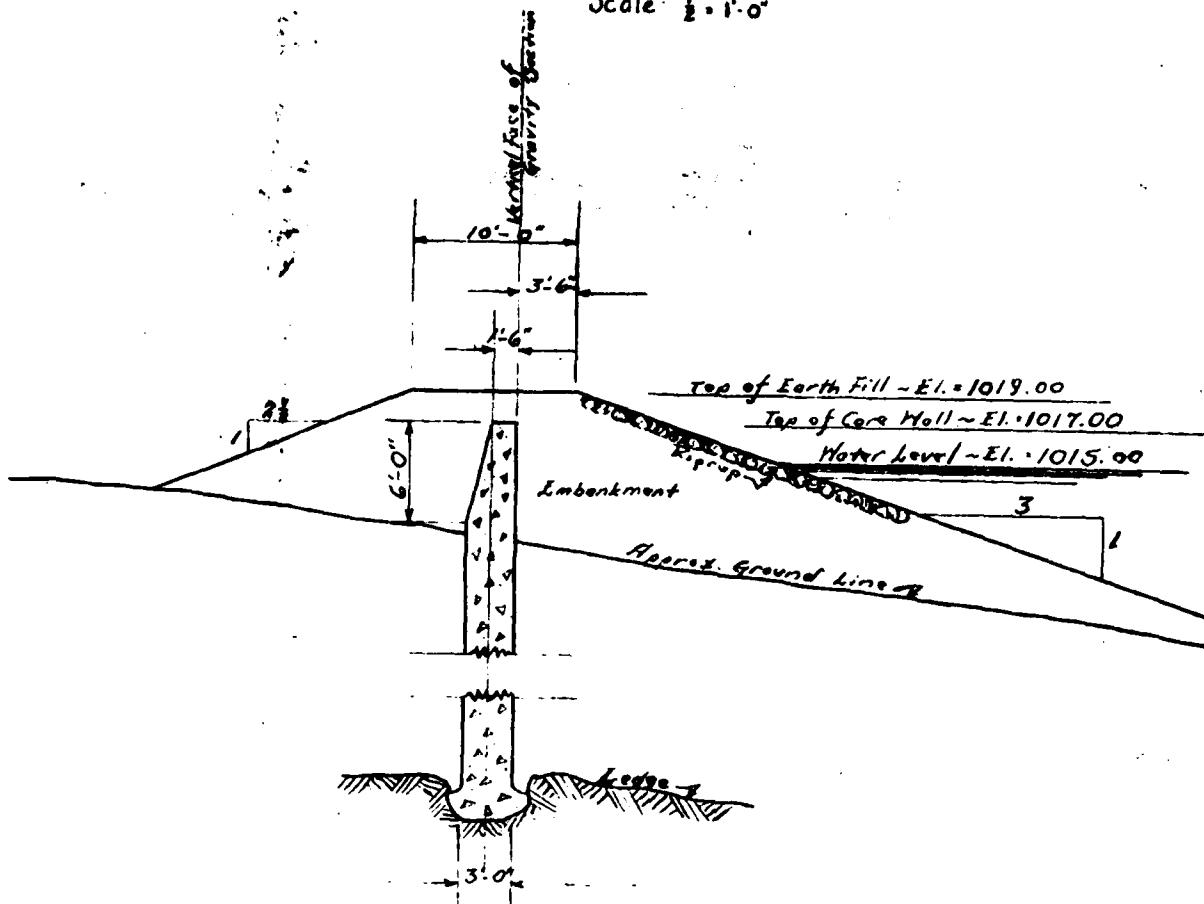
GRAVITY EJECTION

Keys at Level Rock

NOTE: Cut Keyways (longitudinal)

PLAN OF WELL

Scale: $\frac{1}{2}": 1'-0"$



TYPICAL CORE WALL SECTION

Scale $\frac{1}{8}$ " = 1'-0"

FOR THE COMMISSIONERS OF THE
PALISADES INTERSTATE PARK

DETAILS

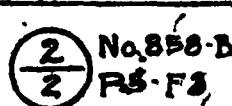
BEAVER POND DAM (WELCH LAKE) OF

Scale: as shown

June 1929

Revised Aug. 1933.

W^m A. Welch
Chief Engr.



No. 858-B
P5-F3

DAM-12

typed print received

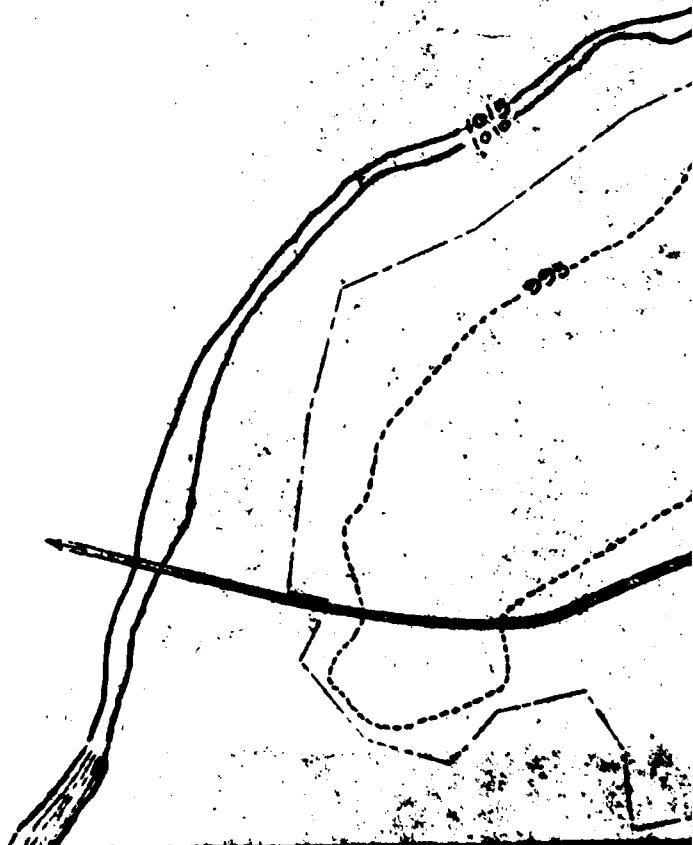
1

True Elevations referred to U.S. Geological Survey Datum.

CMPARATIVE TABLE OF DATA

	CONV. R.L.F.	CONV. R.L.F.	DIFFERENCE
Elevation of H.W.	1015	993	22 feet
Max. Height of Dam	32 feet	10 feet	22 feet
<u>Capacity</u>	1,213,725,130 gallons	164,504,000 gallons	1,049,255,130 gallons
Area Water Surface	216 acres	91.5 acres	124.5 acres
Average Depth	27.5 feet	5.5 feet	22 feet
Max. Depth	35 feet	13 feet	22 feet
Area Land owned		108.3 acres	

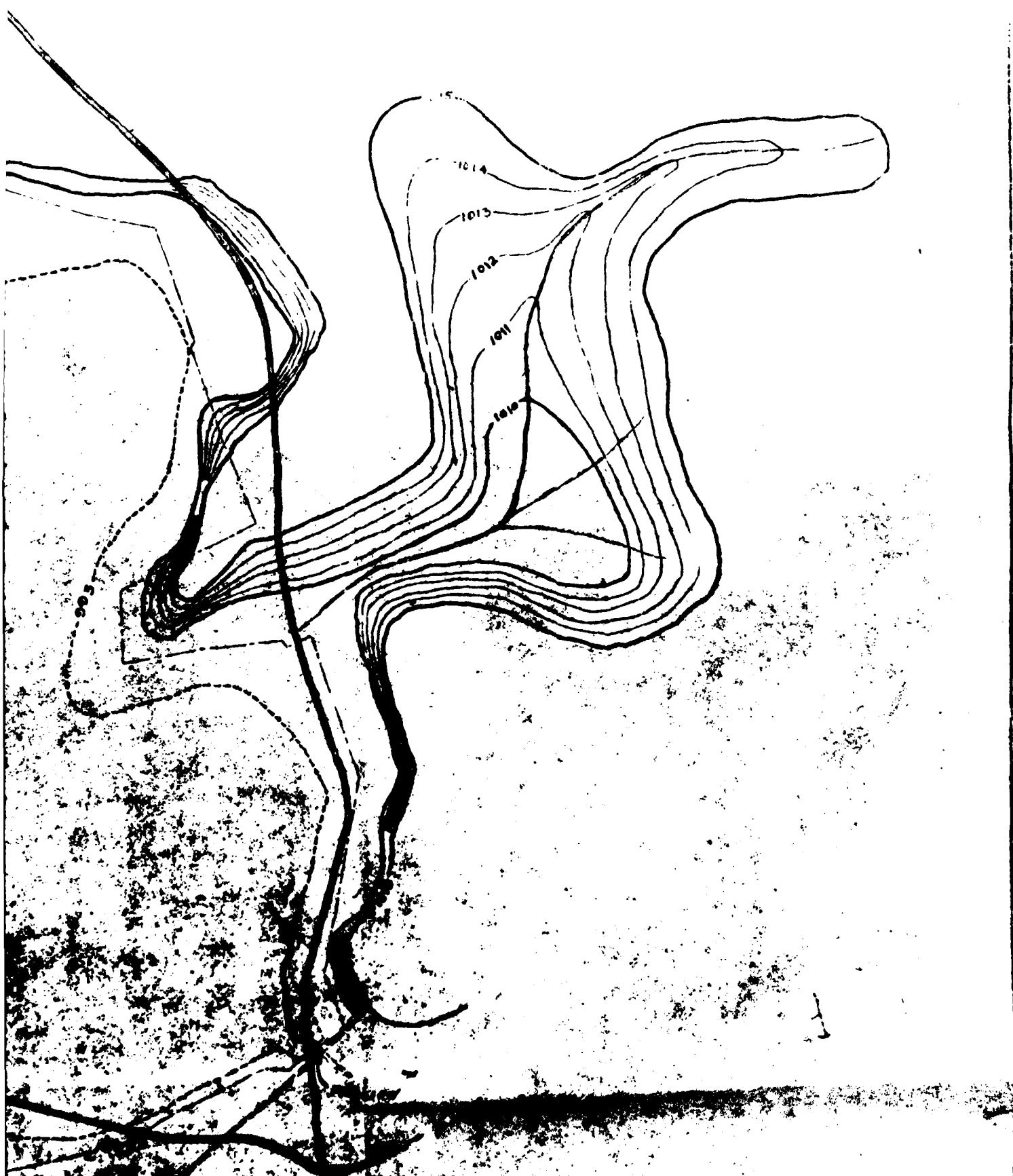
TORREDO & SIFFERY

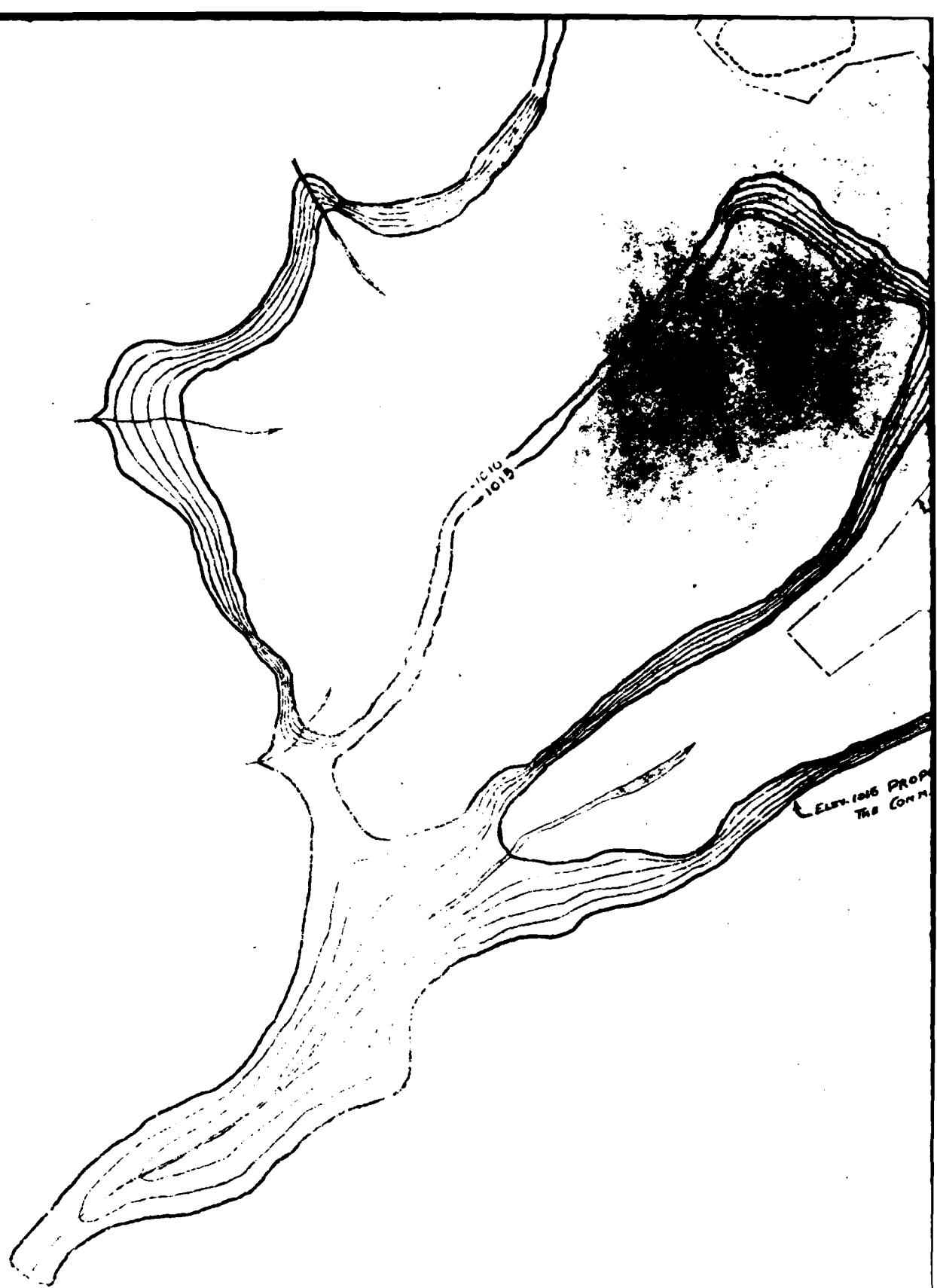


2



3





4



CAPACITIES BETWEEN GIVEN ELEVATIONS

ELEV.	CAPACITIES (GALLONS)	CAPACITIES FROM ELEV. 1015 TO GIVEN ELEV. (GAL)
1015		
	68,840,310	
1014		68,840,310
	65,650,090	
1013		134,490,400
	62,992,820	
1012		191,483,220
	60,498,240	
1011		257,981,460
	58,196,270	
1010		316,77,730
	733,071,400	
993		9255,130
Bottom	164,500,000	55,130



FOR THE COMMISSIONERS OF THE
PALISADES INTERSTATE PARK

PROPOSED

LAKE AT BEAVER POND

TOWNS OF HAVERSTRAW AND STONE POINT
ROCKLAND COUNTY

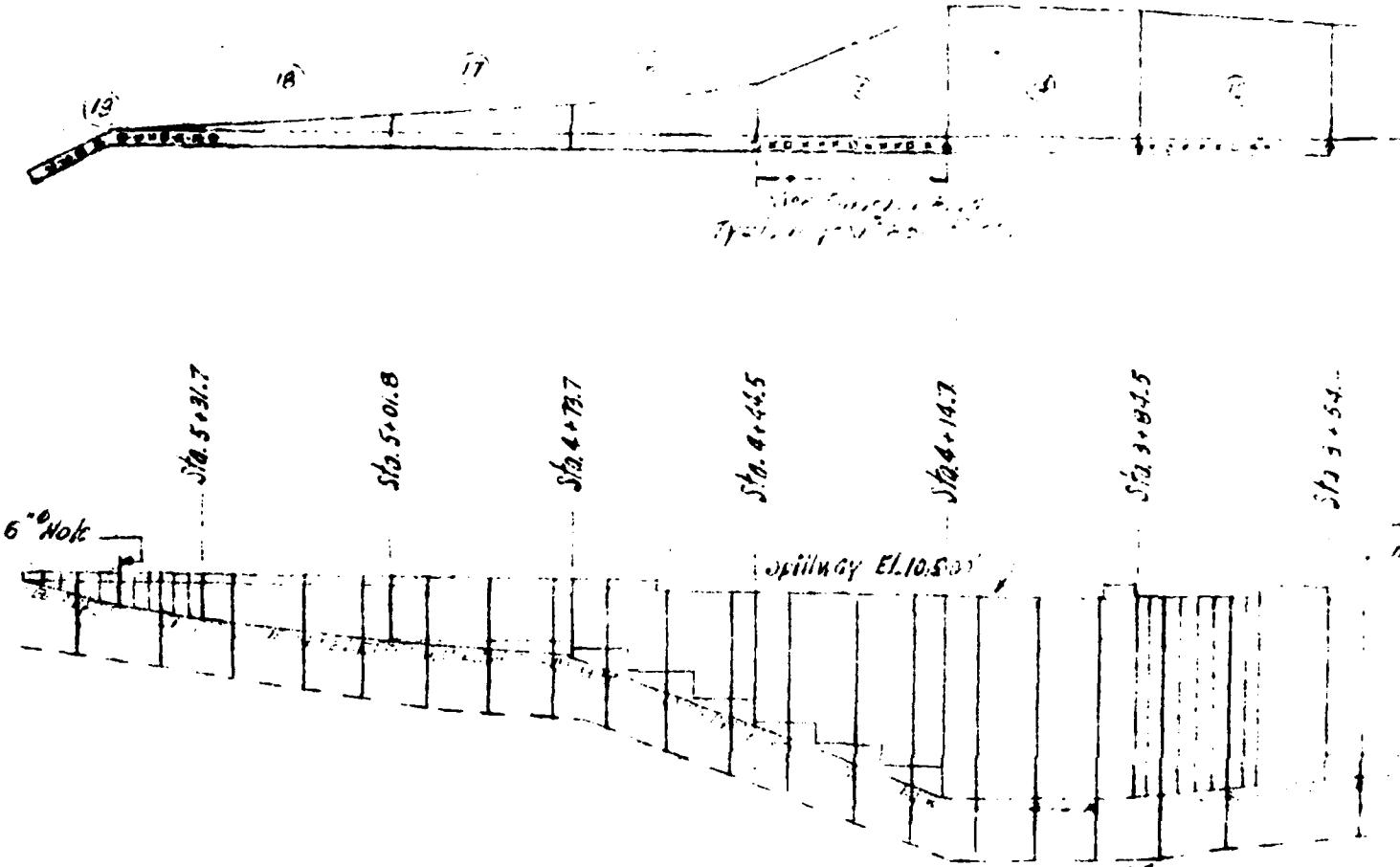
SCALE 1"-200'

Revised - FEB. 1928

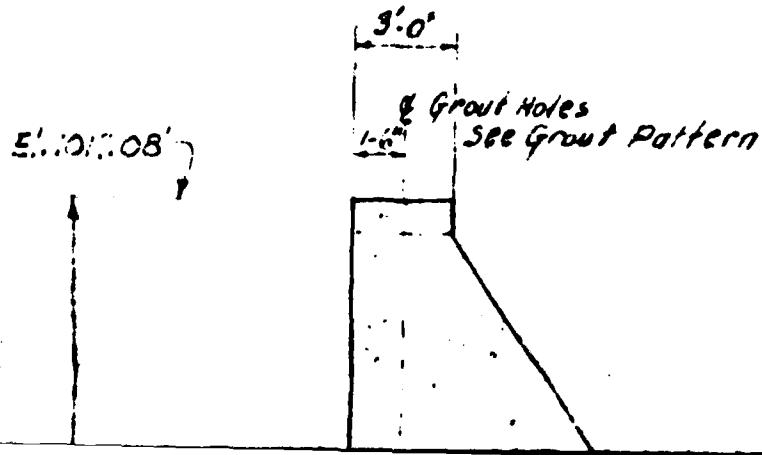
W.H. A. Weller
CHIEF ENGR.

6

1

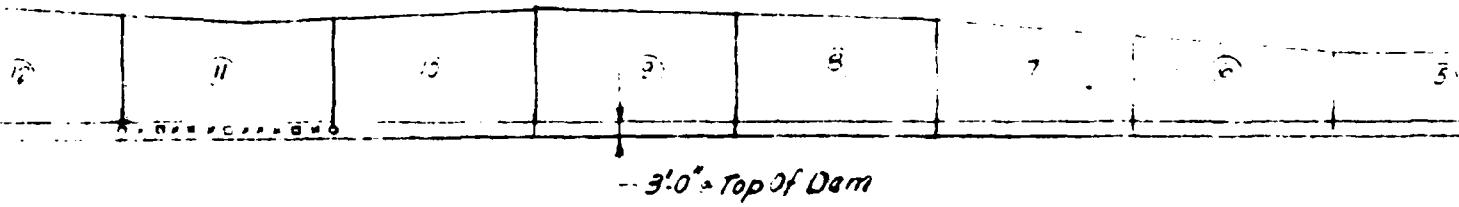


~~2 1/8" Grout Holes 10' 6" -
Cement Grout. is to
be installed at 20° C.
TYPE~~



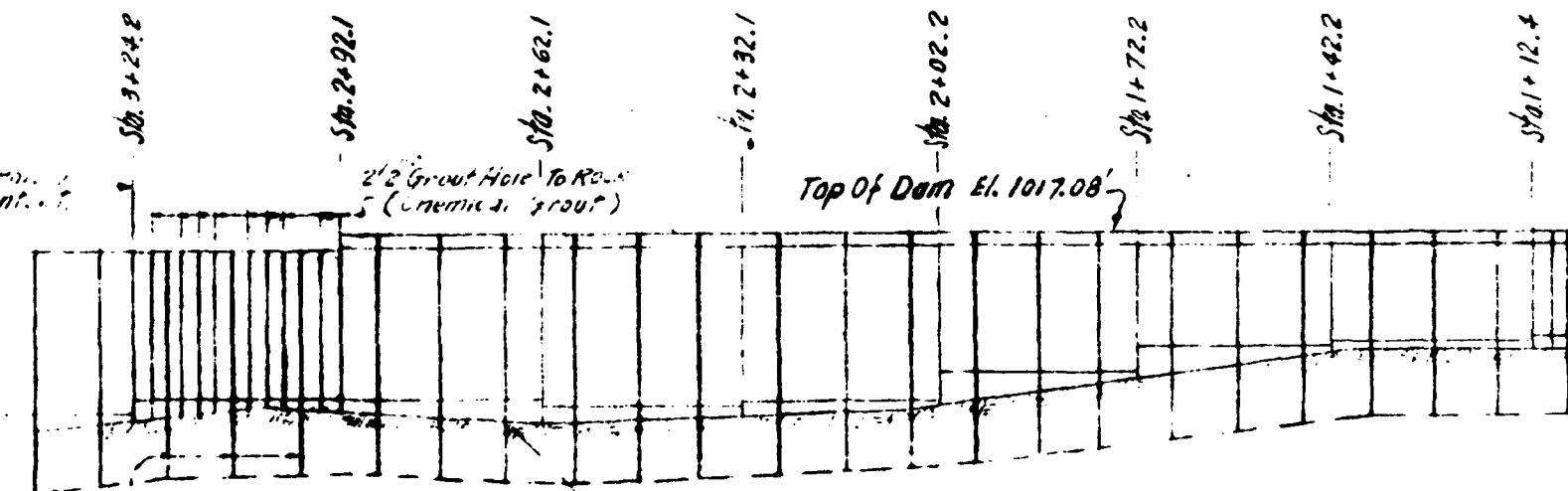
FLOW

2



PLAN

Scale: 1:20



Hole
A = 0.1% To
grouting.

ELEVATION

Upstream Face

Scale: 1:20'

3

5.

2

1

2

7

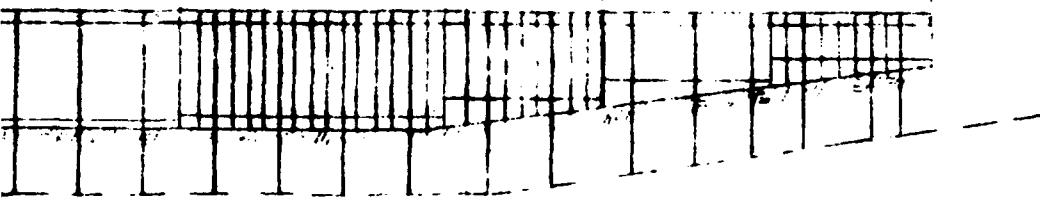
Sta 1 + 12.4

Sta 0 + 72.6

Sta 0 + 48.7

Sta 0 + 23

Sta 0 + 30



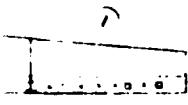
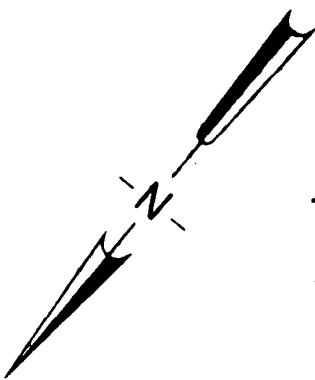
9" Minimum Cover. 14" Dia.

Bolt & Grout Hole

LEGEND

O -

O -

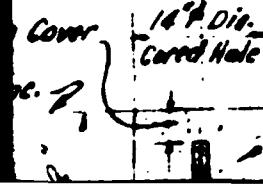


10-10-23

10-10-23



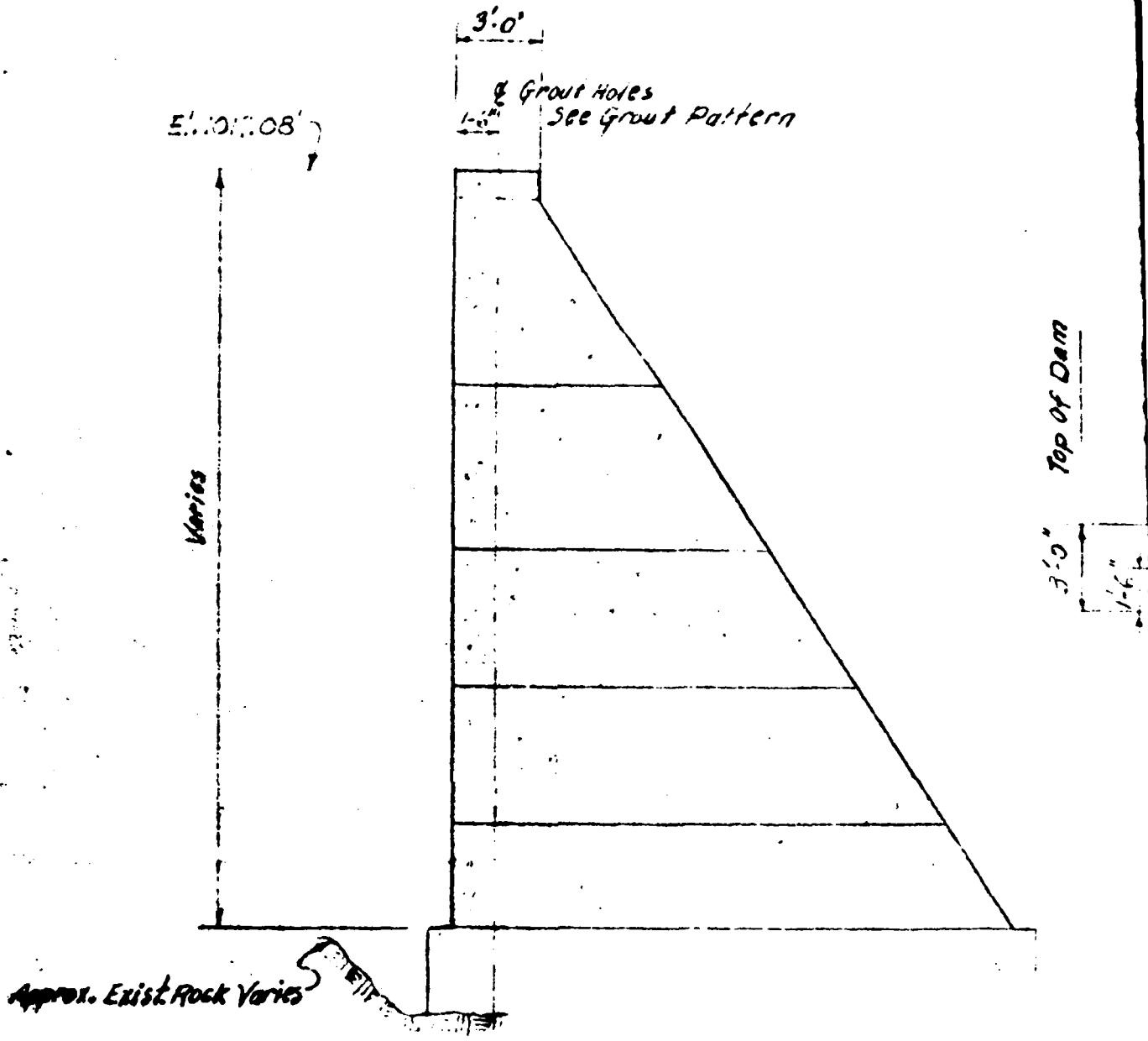
8 Bolt & Grout Hole



Fill With Cans.
After Tensioning
& Grouting Bolt

LEGEND

- - 6" Hole To Be Filled With Epoxy Setting Sealant.
- - 2 1/8" Grout Hole 10 feet into Foundation
Grouted With Cement Grout. These Holes Will
Be Installed After Grouting.
- × - Existing grout holes from previous grouting.

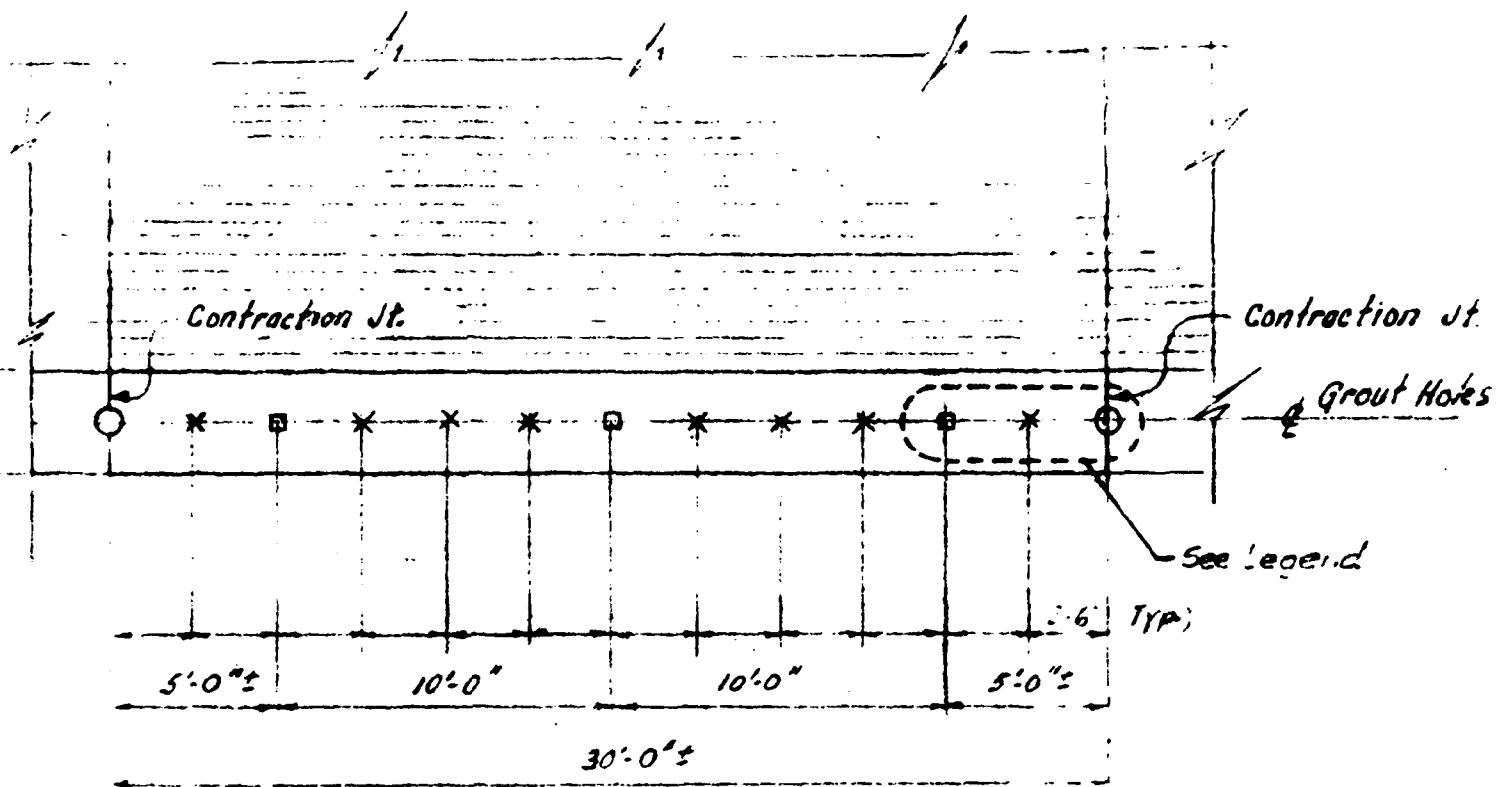


TYPICAL DAM CROSS SECTION
Scale 1/4" = 1:0"

5

TYP

Upstream Face
Scale: 1:20'



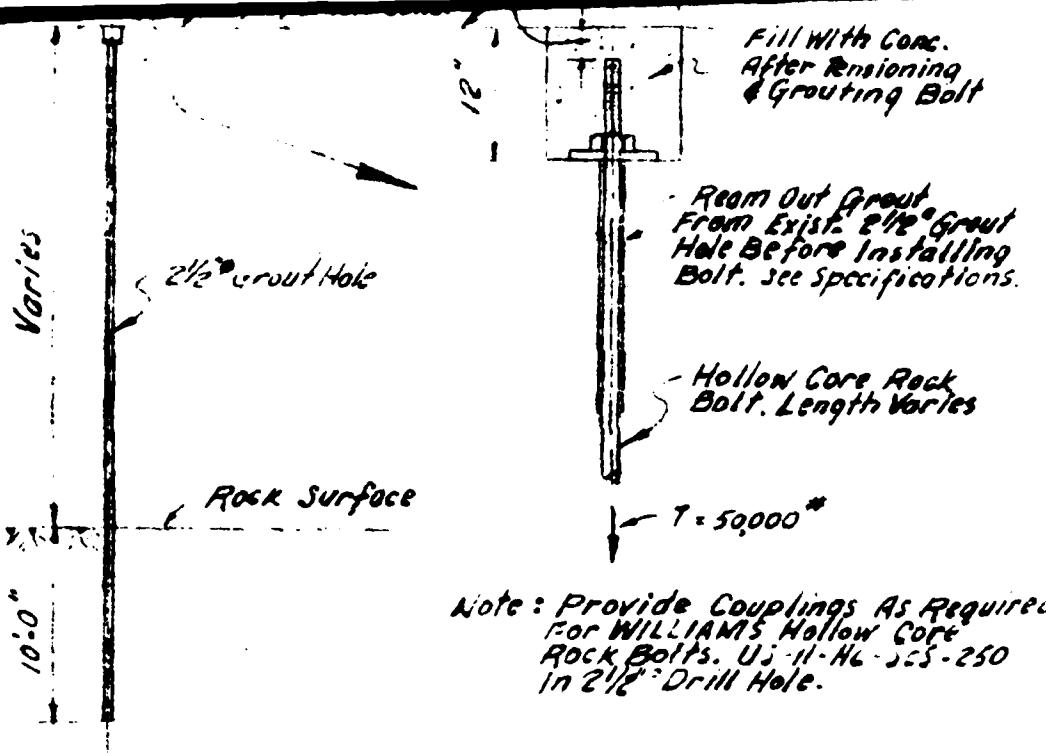
TYPICAL GROUT HOLE PATTERN

BARS ① TO ⑩

Scal's 4" = 1'-0"

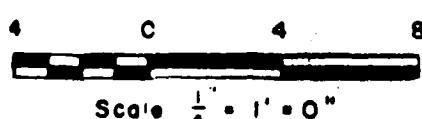
6

x = 2.



ROCK BOLT DETAIL

No Scale



7

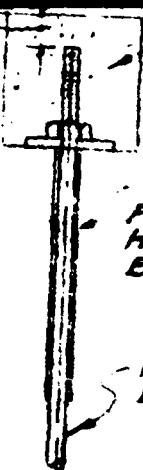
	4-18-78 Construction	NO.	REVISIONS	DATE
DATE ISSUED FOR	DRAWN BY E. OPISTO	CHECKED	APPROVED	
DATE MADE 4-18-78	IN CHARGE	S. K. K.	M. L. M.	

PALIS
BEAR

LAK

M
CHAS. T
BOSTON, MASS.

121



X = 2 $\frac{1}{2}$ " Grout Hole To Rock To Be Chemically grouted.

- Ream Out Grout
From Exist. 2 $\frac{1}{2}$ " Grout
Hole Before Installing
Bolt. see Specifications.

- Hollow Core Rock
Bolt. Length varies

- T = 50,000*

Note: Provide Couplings As Required
for WILLIAMS Hollow Core
Rock Bolts. UJ-H-H6-SGS-250
In 2 $\frac{1}{2}$ " Drill Hole.

K BOLT DETAIL

No scale

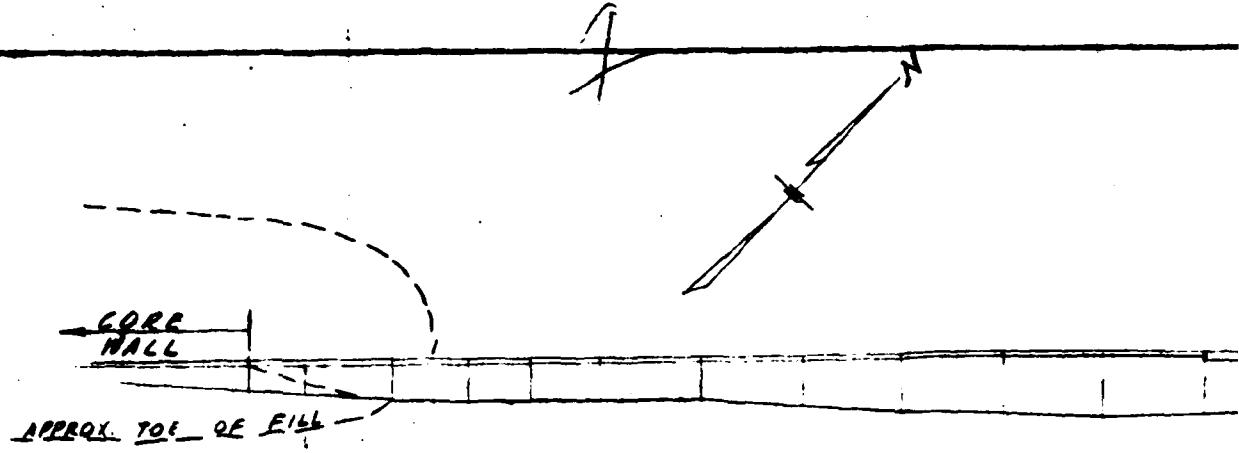
40

0

7

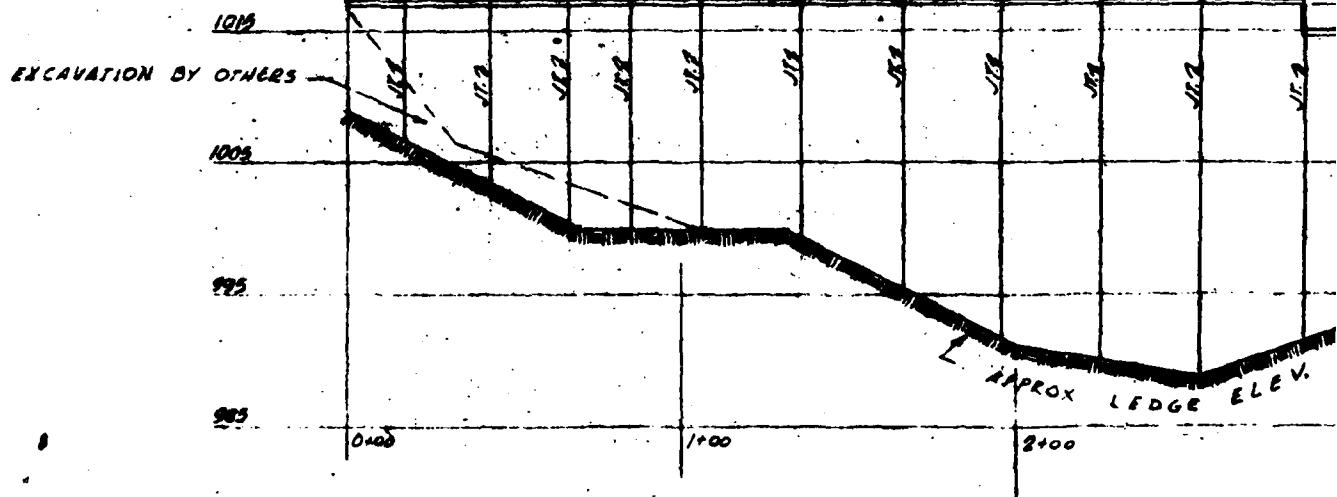
R.F.C.W.D.
Final

MAY 9, 1978
Diagrams
W.S.P.

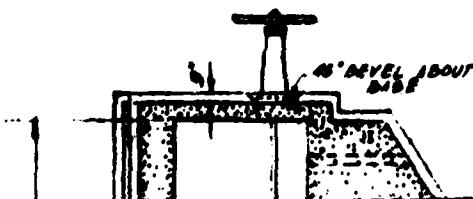


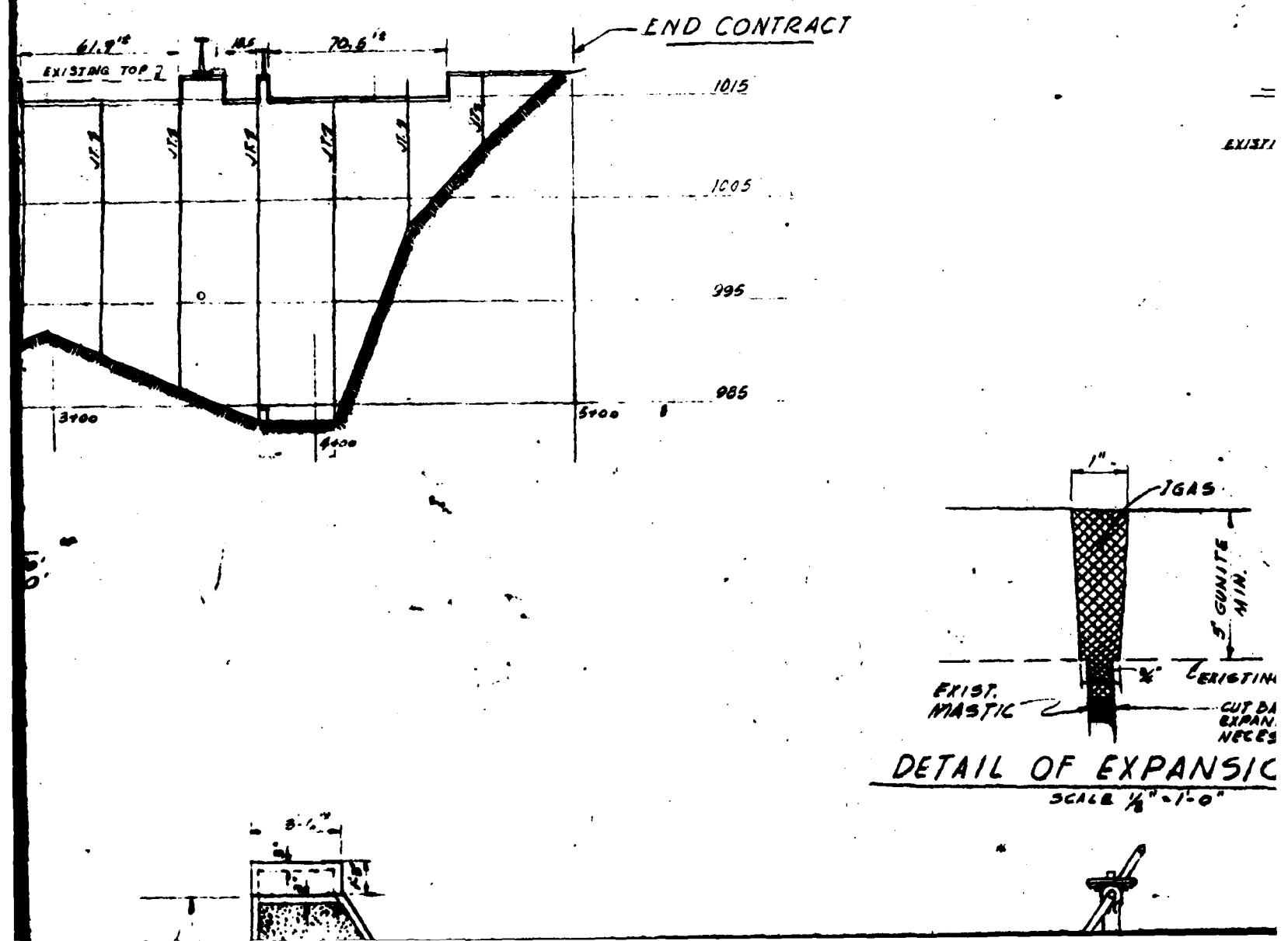
PLAN
SCALE: 1" = 40'

BEGIN CONTRACT

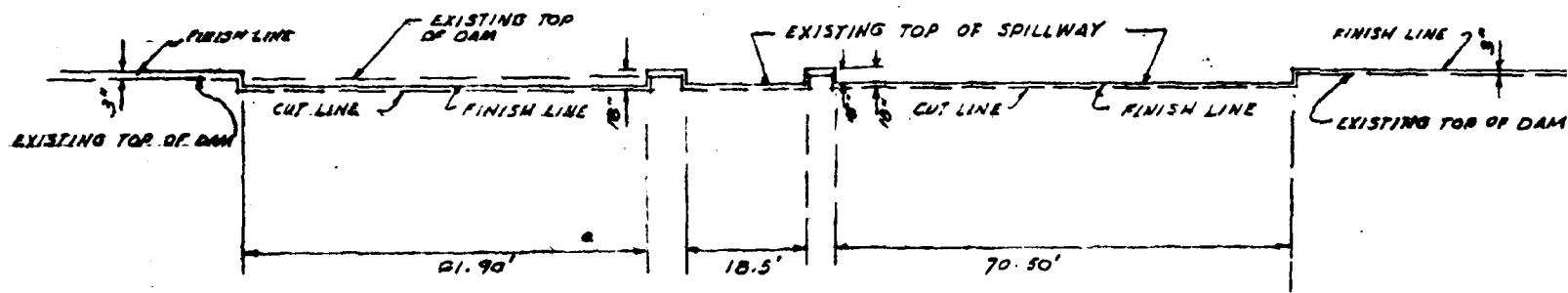


PROFILE
SCALE: HOR. 1" = 40'
VERT. 1" = 10'





3



• SPILLWAY
• EXISTING CONCRETE TO BE REMOVED
ITEM #80 A
SCALE 1"- 20'

3' GROUT
LINE

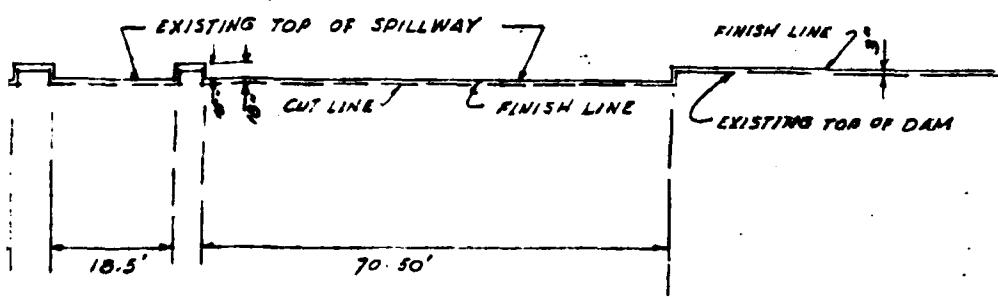
EXISTING DAM

CUT BACK INTO EXISTING
EXPANSION JOINT WHERE
NECESSARY A.O.B.E.

VISION JOINT

7'-0"

4



PILLWAY
CONCRETE TO BE REMOVED
M. "80 A
LE 1" - 20'

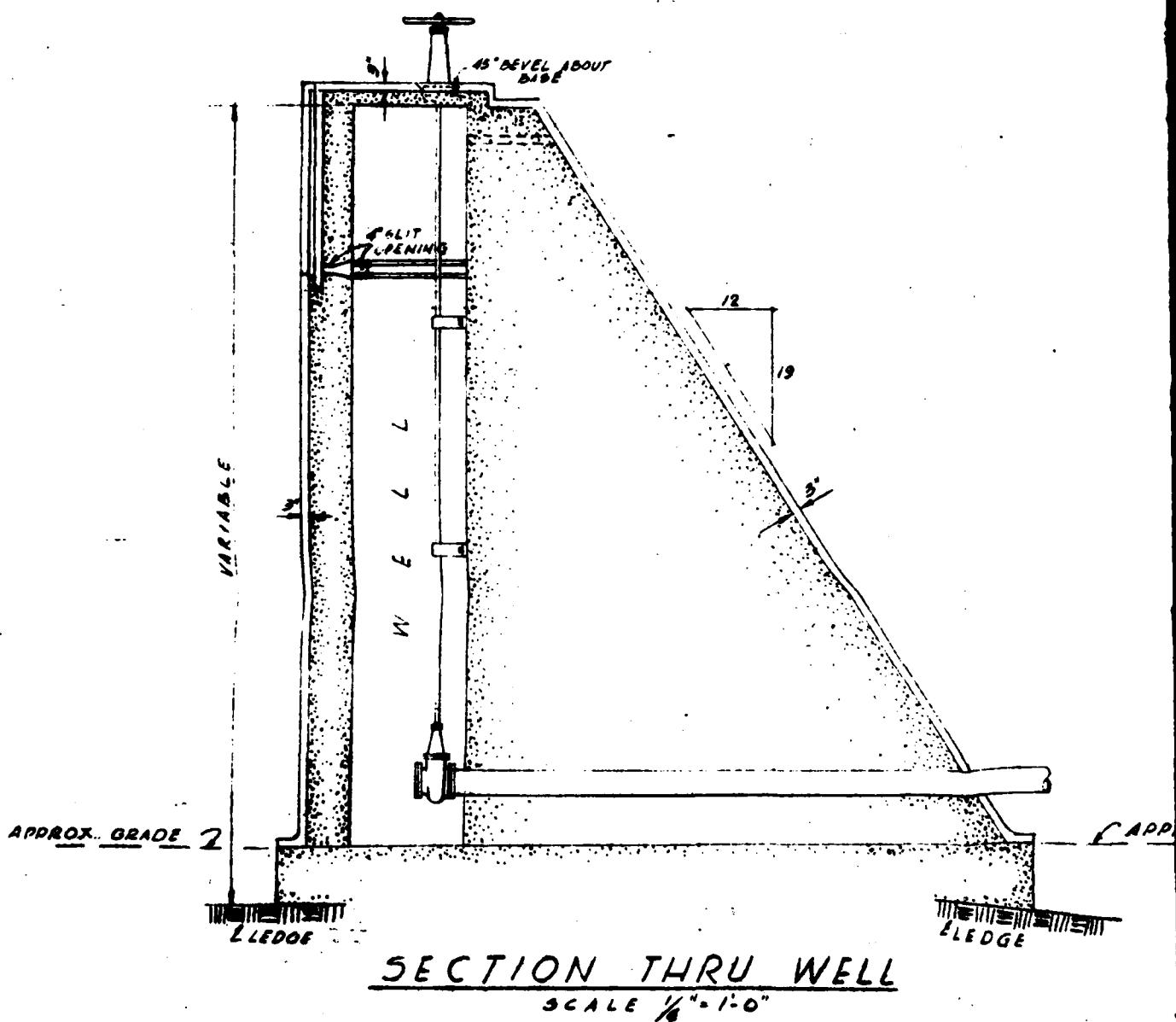
7'-0"

1/4" HOOKED EXPANSION BOLTS

0+00

1+00

2+00

PROFILSCALE: HOR.
VERT.

TILE
8'-0"
8'-10"

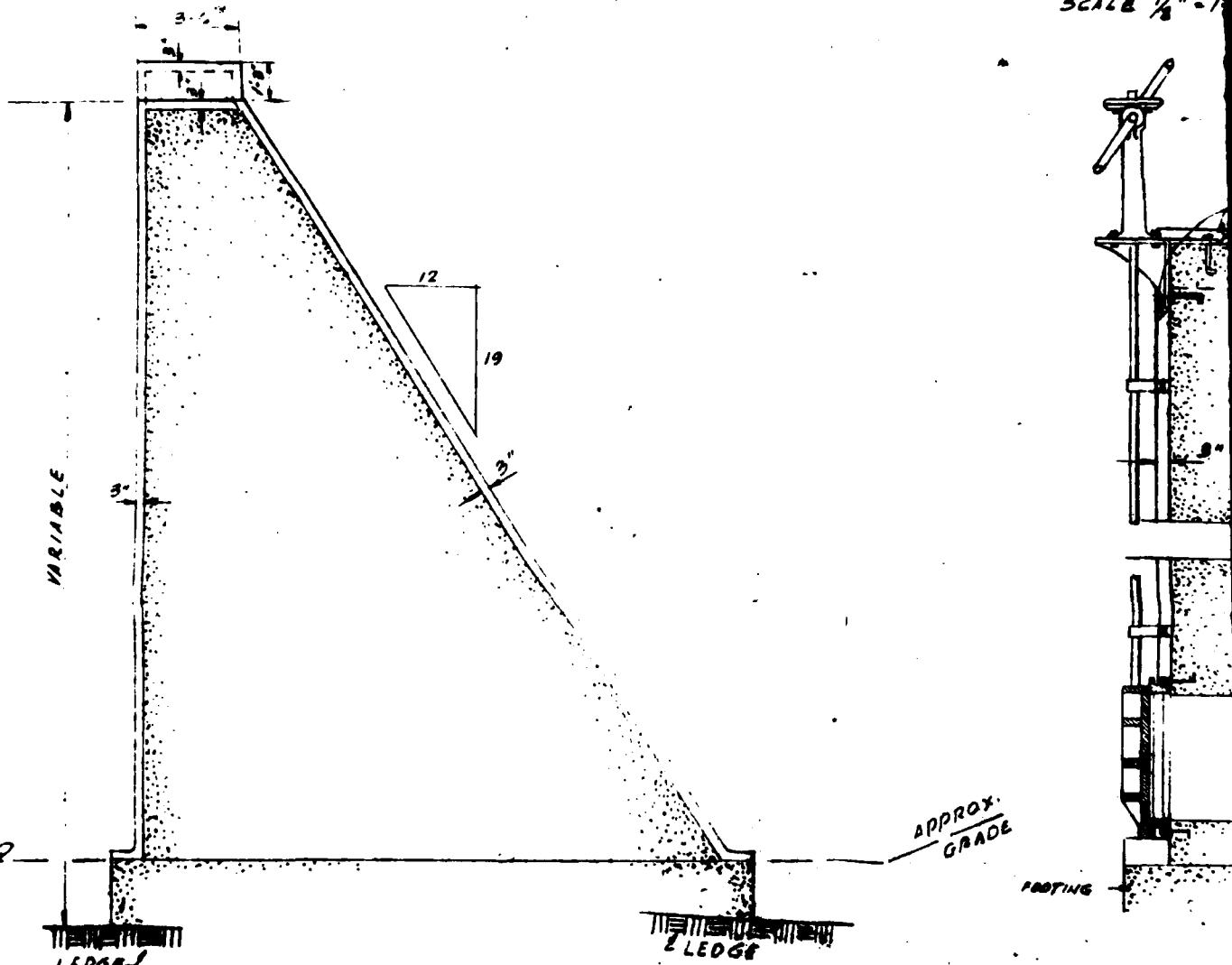
5'00

5'00



DETAIL OF EXPA

SCALE $\frac{1}{16}$ " = 1'



SECTION THRU SPILLWAY

SCALE $\frac{1}{16}$ " = 1'-0"

SECTION

6

SCALE 1" = 20'

IGAS

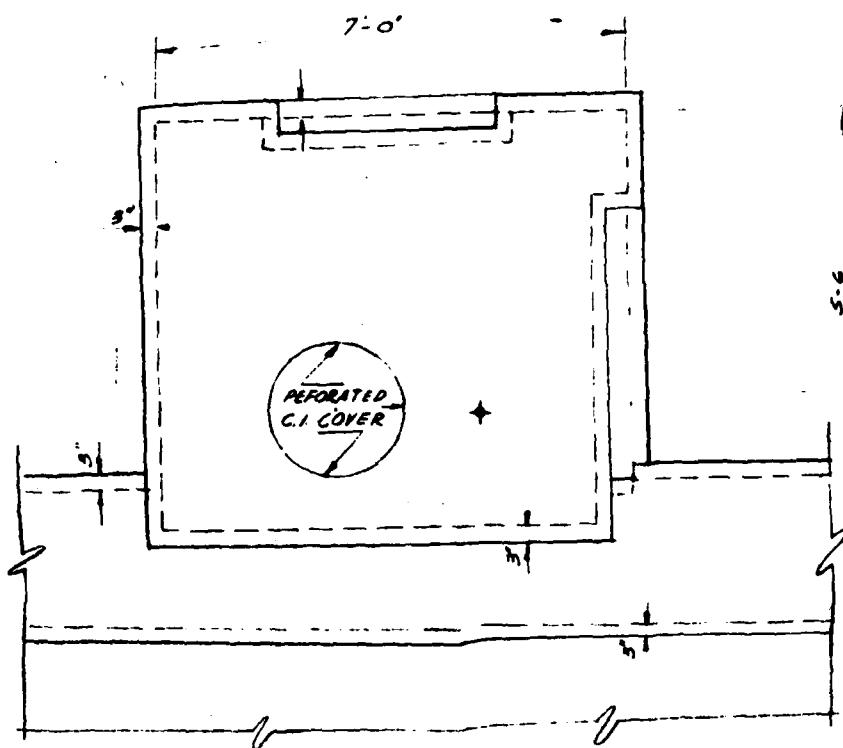
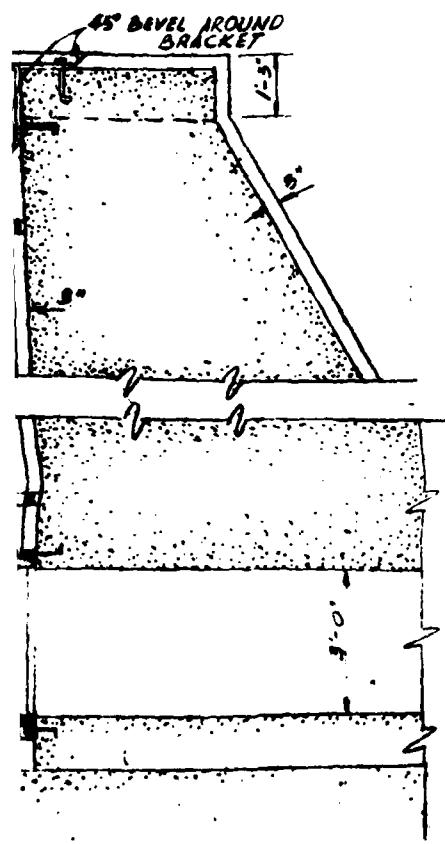
REINFORCING
BARS

X EXISTING DAM

CUT BACK INTO EXISTING
EXPANSION JOINT WHERE
NECESSARY A.O.B.E.

PANSION JOINT

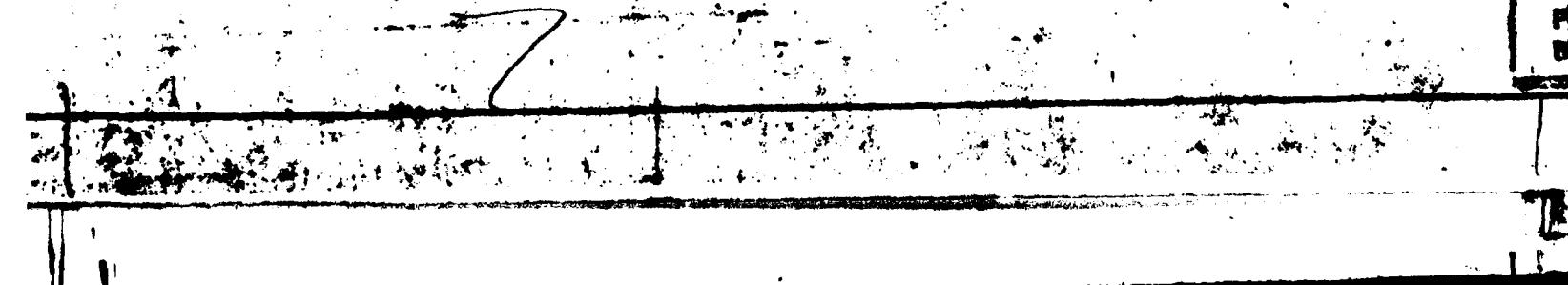
" = 1'-0"

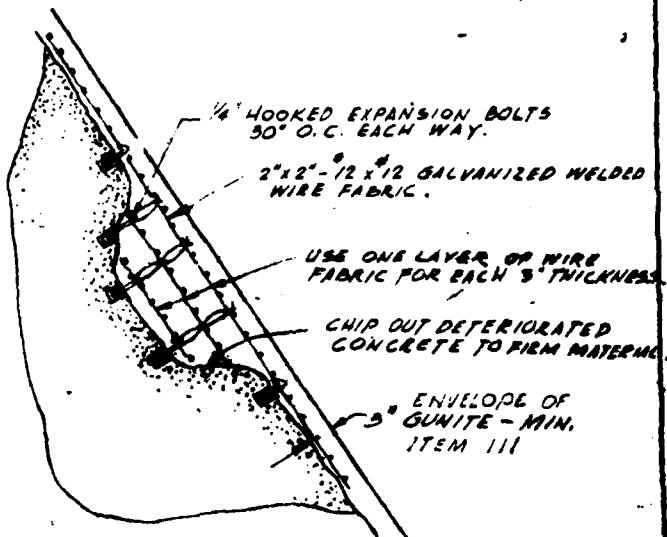
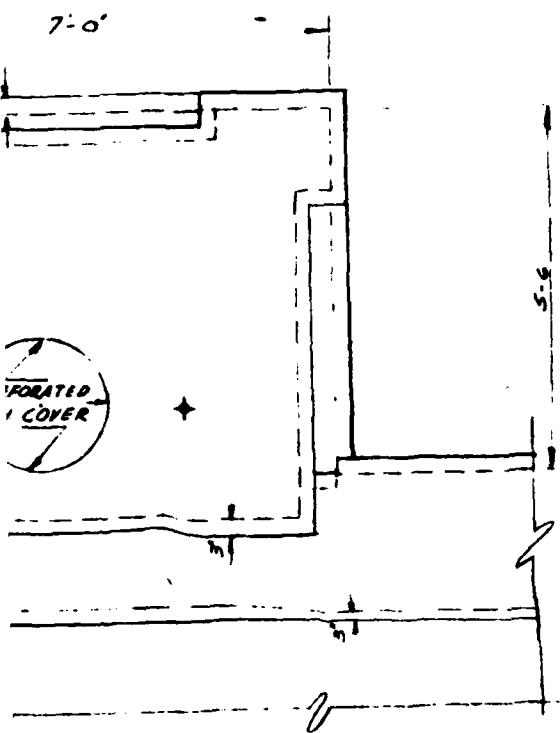


PLAN OF WELL
SCALE $\frac{1}{16}$ " = 1'-0"

ION THRU SLUICE GATE

SCALE $\frac{1}{16}$ " = 1'-0"





TYPICAL DAM REPAIR
NOT TO SCALE

IN OF WELL
SCALE $\frac{1}{8}$ " - 1'-0"

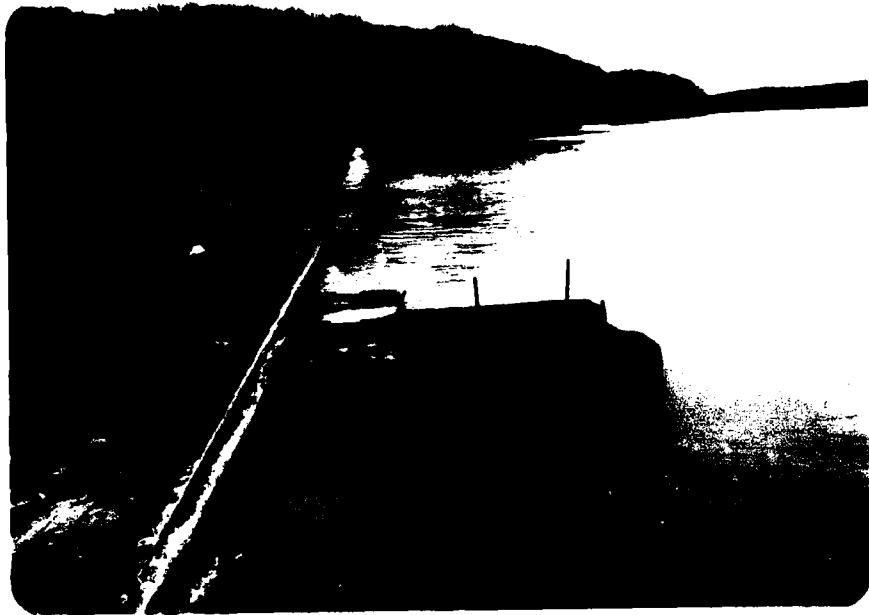
REPAIR - LAKE WELCH DAM
HARRIMAN STATE PARK ROCKLAND CO.
NEW YORK

DRAWN BY	DETAILS	DRAWING NO.
DAWSON BY PC.S.	OF DAM REPAIRS	2
MAILED BY		13 SEP 1968
CHEKED BY H.M.D.		
DATE 7/17/68		

PALISADES INTERSTATE PARK, COMMISSION
BEAR MOUNTAIN, NEW YORK

PHOTOGRAPHS

APPENDIX B



2. VIEW OF CREST OF SPILLWAY AND
INTAKE STRUCTURE FOR HIGH LEVEL
OUTLET.



3. VIEW OF DOWNSTREAM CHANNEL.
NOTE VEGETATION.



4. VIEW OF DOWNSTREAM FACE OF DAM.
NOTE SEEPAGE THROUGH CONSTRUCTION
JOINT AND GUNITE SURFACE REMOVED.



5. VIEW OF DOWNSTREAM FACE OF SPILL-
WAY AND HIGH LEVEL OUTLET. NOTE
FLOW THROUGH OUTLET AND THE EXPOSED
ROCK OF THE DOWNSTREAM CHANNEL.

6. VIEW AT DAM CREST. NOTE GUNITE SURFACE OVER THE CONCRETE.



7. VIEW OF OPERATING MECHANISM FOR SLUICE GATE. (RESERVOIR DRAIN)





8. VIEW OF CREST AND DOWNSTREAM FACE
OF EARTH EMBANKMENT. (LOOKING RIGHT)

VISUAL INSPECTION CHECKLIST

APPENDIX C

VISUAL INSPECTION CHECKLIST

1) Basic Data

a. General

Name of Dam LAKE WELCH (FORMERLY KNOWN AS BEAVER POOD DAM)
Fed. I.D. # NY 283 DEC Dam No. 196-854
River Basin HUDSON
Location: Town LETCHEWORTH VILLAGE County ROCKLAND
Stream Name MINISCEONGO CREEK
Tributary of HUDSON RIVER
Latitude (N) 41° 13' 44" Longitude (W) 74° 4' 20"
Type of Dam CONCRETE GRAVITY & EARTH WITH CENTRAL CONCRETE COREWALL.
Hazard Category HIGH
Date(s) of Inspection APRIL 24, 1980
Weather Conditions 75° SUNNY
Reservoir Level at Time of Inspection 1015.1 FT. (MSL)

b. Inspection Personnel TONY DOLICMASCOLO AND JYOTINDRA PATEL

c. Persons Contacted (Including Address & Phone No.)

ROBERT SANTORO, SENIOR PARK ENGINEER, PALISADES
INTERSTATE PARK COMMISSION, ADMINISTRATION BUILDING,
BEAR MOUNTAIN, NY 10511, PHONE NO. (914) 736-2701

d. History:

Date Constructed 1929-1937 Date(s) Reconstructed 1959 and 1978

Designer M.R. W.A. WELCH

Constructed By (UNIVERSITY)

Owner NEW YORK STATE PARKS & RECREATION
PALISADES INTERSTATE PARK COMMISSION

2) Embankment - EARTH WITH CENTER CONCRETE CORE (225 FT. LONG)
WALL

a. Characteristics

- (1) Embankment Material _____
- (2) Cutoff Type _____ NONE
- (3) Impervious Core CONCRETE COREWALL LOCATED IN THE
CENTER OF EMBANKMENT
- (4) Internal Drainage System _____ NONE
- (5) Miscellaneous _____ —

b. Crest

- (1) Vertical Alignment _____ GOOD
- (2) Horizontal Alignment _____ STRAIGHT AND ALIGNMENT GOOD
- (3) Surface Cracks _____ NONE OBSERVED
- (4) Miscellaneous _____ —

c. Upstream Slope

- (1) Slope (Estimate) (V:H) _____
- (2) Undesirable Growth or Debris, Animal Burrows _____
- (3) Sloughing, Subsidence or Depressions _____ NONE OBSERVED

(4) Slope Protection NONE

(5) Surface Cracks or Movement at Toe NONE OBSERVED

d. Downstream Slope

(1) Slope (Estimate - V:II) _____

(2) Undesirable Growth or Debris, Animal Burrows LARGE BUSHES AND
A FEW SAPLING SIZE TREES.

(3) Sloughing, Subsidence or Depressions NONE OBSERVED

(4) Surface Cracks or Movement at Toe NONE OBSERVED

(5) Seepage NONE OBSERVED

(6) External Drainage System (Ditches, Trenches; Blanket) NOT
APPLICABLE

(7) Condition Around Outlet Structure NOT APPLICABLE

(8) Seepage Beyond Toe NONE OBSERVED

e. Abutments - Embankment Contact (SOUTHERLY). NORTHERLY CONTACT
IS WITH CONCRETE GRAVITY DAM.

(1) Erosion at Contact NONE OBSERVED

(2) Seepage Along Contact NONE OBSERVED

3) Drainage System — NONE

a. Description of System _____

b. Condition of System _____

c. Discharge from Drainage System _____

4) Instrumentation (Monumentation/Surveys, Observation Wells, Weirs, Piezometers, Etc.) _____

NONE

5) Reservoir

- a. Slopes WITHIN VICINITY OF THE DAM RESERVOIR SLOPES ARE STABLE AND NO INCIDENCE OF ADVERSE CONDITION REPORTED TO THE OWNER.
- b. Sedimentation NO EVIDENCE OF EXCESSIVE SEDIMENTATION OBSERVED. LAKE WATER RELATIVELY CLEAR; NO FLOATING DEBRIS OBSERVED.
- c. Unusual Conditions Which Affect Dam _____

6) Area Downstream of Dam

- a. Downstream Hazard (No. of Homes, Highways, etc.) WELCH CAMP SITE; SEVERAL HOMES; STATE PT. 210 AND PALISADES INTERSTATE PARKWAY.
- b. Seepage, Unusual Growth NO SEEPAGE OBSERVED. NO UNUSUAL GROWTH
- c. Evidence of Movement Beyond Toe of Dam NONC OBSERVED
- d. Condition of Downstream Channel CHANNEL IS ALSO SPILLWAY CHANNEL WHICH IS OVERGROWN WITH TREES AND OTHER VEGETATION. (ALSO SEE ITEM #7.)

7) Spillway(s) (Including Discharge Conveyance Channel)

SPILLWAY IS BROAD CRESTED WEIR AND IS PART OF CONCRETE DAM.

- a. General THE ORIGINAL SPILLWAY WAS REHABILITATED BY APPLYING A GUNITE SURFACE

- b. Condition of Service Spillway GENERALLY IN GOOD CONDITION. FEW FLEET OF GUNITE SURFACE IS NOT EXISTING ALONG THE CREST OF THE SPILLWAY (SEE PHOTOGRAPH)

c. Condition of Auxiliary Spillway NOT APPLICABLE

d. Condition of Discharge Conveyance Channel IN VICINITY OF DAM THE CHANNEL BANKS AND FLOOR OF CHANNEL IS ROCK AND IS IN GOOD CONDITION. OVERGROWN WITH TREES AND OTHER VEGETATION.

8) Reservoir Drainage ^{and} ~~Reservoir~~ ~~Drainage~~ OUTLET LOW LEVEL - 3' x 3' SLUICE WAY ①
HIGH LEVEL - 12" CI OUTLET PIPE ②

Type: Pipe ② Conduit _____ Other SLUICEDWAY ①

Material: Concrete 2 Metal 1 Other _____

Size: AS NOTED ABOVE Length —
221.2 221.2

Invert Elevations: Entrance ② 984.0 Exit ② 984.5
Entrance ② 1010 Exit ② 991.5±

Physical Condition (Describe): Unobservable ① & ② except ^{as}
below.

Material: _____

Joints: _____ **Alignment** _____

Structural Integrity: CONCRETE WALLS OF SLUICEWAY ARE IN GOOD CONDITION.

Hydraulic Capability: _____

Means of Control: Gate 2 Valve 1 Uncontrolled _____

Reported _____
Operation: Operable (1) Inoperable (2) Other _____

Present Condition (Describe): CONTROL FOR HIGHLEVEL IS
NOT EXISTING EXCEPT THE STEM; SLUICEGATE CONTROL
IN GOOD CONDITION AND REPORTED OPERABLE

9) Structural

- a. Concrete Surfaces ORIGINAL CONCRETE DAM RESURFACED WITH GUNITE (3 inches). MOST OF WHICH HAS BEEN REMOVED AT DOWNSTREAM FACE. THE CONDITION EXPOSE CONCRETE IS GOOD.
- b. Structural Cracking NONE OBSERVED
- c. Movement - Horizontal & Vertical Alignment (Settlement) NONE
- d. Junctions with Abutments or Embankments NO EVIDENCE OF PROBLEMS
- e. Drains - Foundation, Joint, Face NONE
- f. Water Passages, Conduits, Sluices 2 OUTLETS - HIGH LEVEL OUTLET & LOW LEVEL OUTLET ARE 12 INCH CI PIPE AND 3 FT SQUARE SLUICEWAY. THE CONDITION OF HIGH LEVEL OUTLET UNDETERMINED; SLUICEWAY IN SATISFACTORY CONDITION
- g. Seepage or Leakage MINOR SEEPAGE OBSERVED AT THE MONOLITH & CONSTRUCTION JOINTS.

- h. Joints - Construction, etc. SOME JOINTS FILLED WITH
DAKUM TO PREVENT SEEPAGE.
- i. Foundation IS ROCK ACCORDING TO AVAILABLE
DOCUMENTS & VISUAL INSPECTION OF DOWNSTREAM
DAM
- j. Abutments NO EVIDENCE OF SEEPAGE
- k. Control Gates HIGH LEVEL OUTLET - INOPERABLE
LOW LEVEL OUTLET IS REPORTED OPERABLE
- l. Approach & Outlet Channels 'NONE'
- m. Energy Dissipators (Plunge Pool, etc.) NONE
- n. Intake Structures FOR HIGH LEVEL OUTLET ; STRUCTURE
COMPLETED FULL OF WATER.
- o. Stability THERE ARE NO VISUAL INDICATIONS THAT SPILLWAY
SHOWS ANY EVIDENCE OF STABILITY PROBLEMS
- p. Miscellaneous

HYDROLOGIC DATA AND COMPUTATION

APPENDIX D

TAMS

Job No. 1551 Sheet 1 of 4
Project LAKE WELCH PHASE I INSPECTION Date MAY 14 198
Subject LOCATION LAT 41° 13' 45" LONG 74° 4' 15" By D.L.C
Chk. by

<u>EM 1110-2-1405.</u>	
$L = 0.5'' = 3.6 \text{ miles}$	Use $C_p = 2$ $640C_p = 400$
$L_{ca} = 2.9'' = 1.1 \text{ miles}$	
$T = C_p (L L_{ca})^{0.5}$	
$F = 3.02 \text{ hours}$	
$t_a = 3.02 / 5.5 = 0.5 \text{ hours.}$	
$Q_p = \frac{640 C_p}{t_p} = \frac{400}{3.0} 133. \text{ cfs/sg mi}$	
$Q = 133 \times 2.87 = 382 \text{ cfs}$	

HYDROMET REPORT No. 51.

DROMET REPORT NO. 31 PMP 24 hour 200 sec/m IN 100 RAINFALL = 24.5"

10 SQRM.	6 HR	12 HR	24 HR	48 HR
	26	30	33	37
% under Ppt	106.1	122.4	134.7	151.0

TAMS

Job No. 1551-11

Project LAKE WELCH PHASE 1 INSPECTION

Subject EL-AREA-STORAGE RELATION

Sheet 2 of 4
Date MAY 17 1980
By DLC
Ch'k. by _____

EL	H	AREA	MEAN AREA	A STORAGE	STORAGE	(* Ref 5)
988		0				
1010		186			34.44*	
1015	5	218	202	1010	4454	
1016	1	225	221.5	221.5	4675.5	1016.5 4791.3
1018	2	238	231.5	463	5138.5	
1020	2	251	244.5	489	5627.5	

Total Surcharge Storage 5630 - 4450 = 1180 Acre feet
~ 7.7 inches of R/O

CROSS SECTIONS BELOW DAM (Minisceongo Creek)

400ft	26+00	52+00	76+00	
3130	1020	1120	960	560
3280	1000	1180	940	540
3380	980	1250	920	520
3385	975	1370	917	500
3450	975	1440	917	480
3500	970	2000	900	500
3590	970	2090	920	505
3590	980	2150	940	505
3630	1000	2260	960	520
3690	1020		720	540

TAMS

Job No. 1551-11

Project LAKE WELCH

Subject _____

PHASE 1 INSPECTION

Sheet 3 of 4

Date MAY 14 1980

By DLC

Ch'k. by _____

BANK CROSSING		CREST E.	1015.	DAM	1016.3.
SPILLWAY		LENGTH	152.0'	DAM	788
		USE C = 0.88 x 3.087 = 2.624		TOP	1010
EL	H _s	Q _s	H _o	Q _e	Q _t
1015		0			0
1016		400			400
1016.5		780			730
1017		1130	0.5	381	1510
1019		3190	2.5	4263	7450
1020		4460	3.5	7062	12110

TOP OF GRAVITY DAM 1016.3

EL	A	S	D
981	0	0	0
1015	218	4454	0
1016.5	228	4191.3	730
1017	232	4907	1510
1019	245	5383	7450
1020	251	5627.5	12110

TAMS

Job No. 1551-11

Project LAKE WELCH PHASE 1 INSPECTION

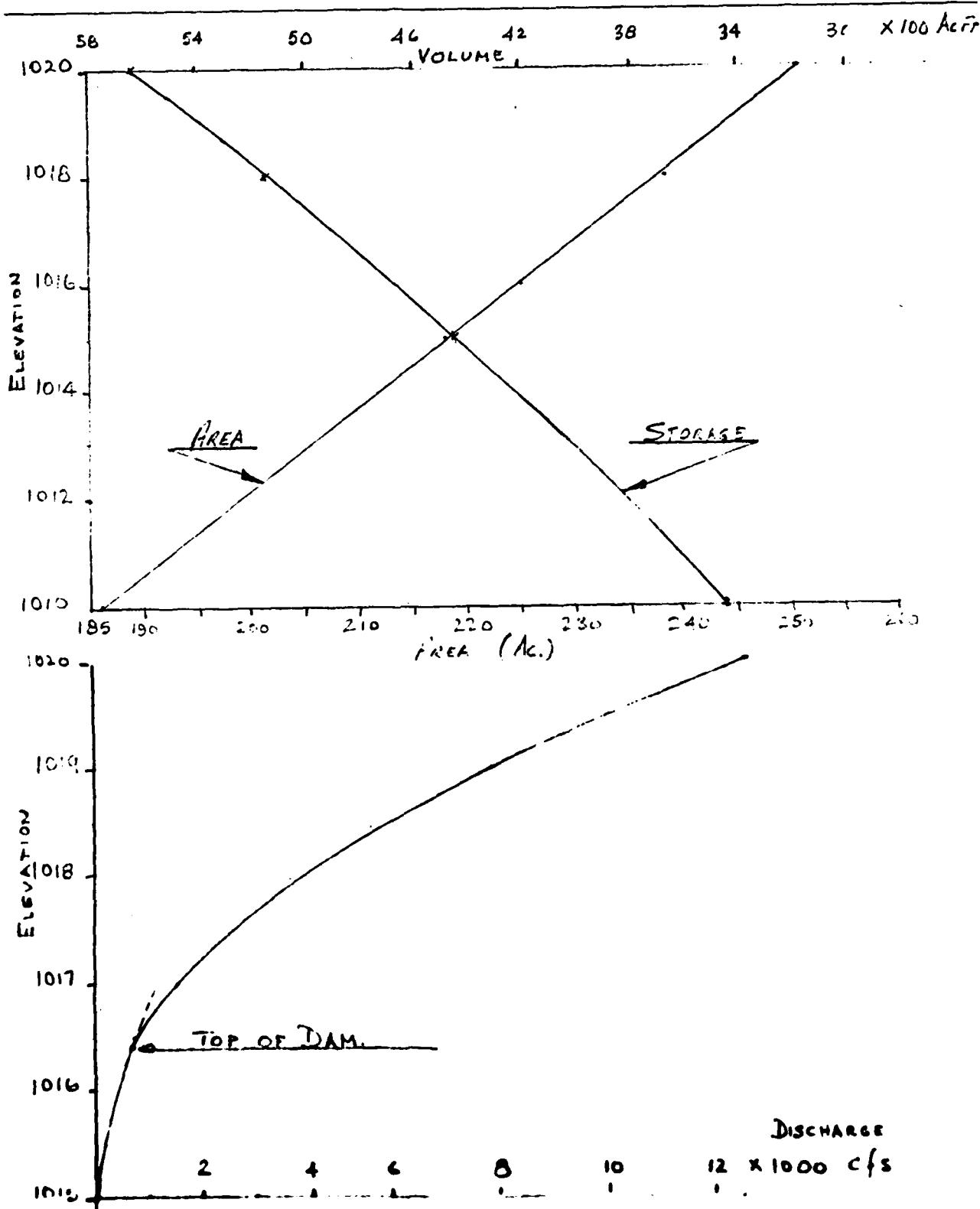
Subject HYDROLOGIC/HYDRAULIC COMPUTATION

Sheet 4 of 4

Date MAY 14 1980

By DLC

Ch'k. by _____



100
110
105
5160
506
8210
520
8270
540
500
8100
500

S1

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	1
ROUTE HYDROGRAPH TO	2
ROUTE HYDROGRAPH TO	3
ROUTE HYDROGRAPH TO	4
ROUTE HYDROGRAPH TO	5
ROUTE HYDROGRAPH TO	6
ROUTE HYDROGRAPH TO	
END OF NETWORK	

FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAW SAFETY VERSION JULY
LAST MODIFICATION 26 FEB 79

RUN DATE = 8G/05/21.
TIME = 19:02:01.

PHASE 1 INSPECTION AND SAFETY EVALUATION OF LAKE WELCH DAM 1551-11
SPILLWAY ADEQUACY TESTS USING PROBABLE MAXIMUM FLOOD
TAMS ENGINEERS & ARCHITECTS

NG	NHR	NMIN	1DAY	IHR	IMIN	METRC	IPLT	IPRT	INSTAN
100	0	30	0	0	0	0	0	0	0
			JOPER	NUT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN = 1 NRIO = 2 LRTIO = 1

RIOS = 1.00 .50

SUB-AREA RUNOFF COMPUTATION

UNIT HYDROGRAPH AND INFLOW HYDROGRAPH COMPUTATION

ISIAO	ICOMP	IECON	ITAPE	JPLT	JPRI	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	0	0	0

INHDG	TUNG	TAREA	SNAP	TRSDA	TRSPC	ratio	ISNOW	ISAME	LOCAL
1	1	2.87	0.00	2.87	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R72	R96
0.00	22.50	106.10	122.40	134.70	151.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LROPT	STRKR	DTRKR	RTIO1	ERAIN	STRSK	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	2.00	.05	0.00	.15

UNIT HYDROGRAPH DATA

TP = 3.02 CP = .63 NTA = 0

RECEDITION DATA

STIO = -1.00 QRESN = -.05 RTIOR = 3.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SHDTER CP AND TP ARE TC = 6.90 AND R = 3.43 INTERVALS

UNIT HYDROGRAPH 33 END-OF-PERIOD ORDINATES, LAG=	3.00 HOURS, CP=	.63 VOL=	1.00
26. 89 176. 270. 346. 387. 386. 342. 284. 236.			
196. 163. 136. 113. 94. 78. 65. 54. 45. 37.			
31. 26. 21. 18. 15. 12. 10. 8. 7. 6.			
5. 4. 3. 2. 1. 0. 0. 0. 0. 0.			

END-OF-PERIOD FLOW

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6169.	4788.	1859.	936.	\$3635.
CMS	175.	136.	53.	21.	2651.
INCHES	15.52	24.10	25.29	25.29	
MM	394.19	612.06	642.39	642.39	
AC-FT	2374.	3683.	3869.	3869.	
THOUS CU M	2929.	4567.	4773.	4773.	
SUM	29.60	26.63	2.97	94075.	(752.) (676.) (75.) (2663.91)

		PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6169.	4788.	1859.	936.	9365.	
CMS	175.	136.	53.	27.	2651.	
INCHES	15.52	24.10	25.29		25.29	
MM	394.19	612.06	642.39		642.39	
AC-FT	2374.	3687.	3860.		3869.	
THOUS CU FT	2929.	4547.	4773.			
THOUS CU M						

HYDROGRAPH AT STA 1 FOR PLAN 1, RT10.2

1.	1.	1.	1.	1.	2.	2.	2.	2.
2.	2.	2.	3.	3.	4.	4.	5.	6.
7.	7.	7.	8.	8.	9.	10.	12.	15.
23.	32.	51.	77.	110.	144.	171.	187.	195.
157.	136.	115.	97.	81.	68.	57.	48.	41.
38.	41.	47.	55.	64.	72.	78.	83.	78.
97.	107.	126.	153.	186.	223.	260.	292.	319.
361.	376.	399.	444.	524.	645.	807.	1004.	1225.
1872.	2267.	2641.	2933.	3085.	3665.	2875.	2590.	2282.
1880.	1427.	1217.	1043.	897.	777.	675.	587.	509.
								438.

HYDROGRAPH AT STA 1 FOR PLAN 1, RT10.2

		PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3085.	2394.	929.	668.	46817.	
CMS	87.	68.	26.	13.	1326.	
INCHES						
MM						
AC-FT						
THOUS CU FT						
THOUS CU M						

HYDROGRAPH ROUTING

RESERVOIR ROUTING

INSTAQ	ICOMP	IECON	ITAPE	JPLT	IPRT	INAME	ISTAGE	IAUTO	0	0	0
2	1	0	0	0	0	X	0	0	0	0	0
QLSS	CLOSS	Avg	IRSM	ROUTING DATA							
0.0	0.000	0.000	1	10PT	IPMP						
NSTPS	NSTOL	LAG	AMSK								
1	0	0	0								
STAGE	981.00	1015.00	1016.50	1017.00	1019.00	1020.00					

FCDF 0.00 0.00 750.00 1510.00 7450.00 12110.00

CAPACITY= 0. 4454. 4791. 4907. 5383. 5628.

ELEVATION= 981. 1015. 1017. 1019. 1020.

CREL SPNID COAW EXPN ELEVL COAL CAREA EXPL

1015.0 0.0 0.0 0.0 0.0 0.0 0.0

DAM DATA COAD EXPD DAMWID 1.5 748.

STATION 1016.3 0.0 0.0 0.0 0.0 0.0 0.0

2. PLAN 1, RATIO 1

ELEVATION:

461. 1015. 1017. 1017. 1019. 1019.

STATION	TOPEL 1016.3	CODD 0.0	ELEV 0.0	CORL 0.0	CAREA 0.0	EXPL 0.0
CREL 1015.0	SPWID 0.0	COOM 0.0	EXPW 0.0	ELEV 0.0	CORL 0.0	EXPL 0.0

DAM DATA
1016.3 0.0 1.5 788.STATION 2, PLAN 1, RATIO 1
END-OF-PERIOD HYDROGRAPH ORDINATES

	OUTFLOW	STORAGE
0	0	4454.
2	2	4454.
6	7	4455.
17	20	4457.
167	178	4454.
150	144	4455.
148	153	4456.
351	384	4457.
2265	3033	4458.
4374	3855.	4459.
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STORAGE

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	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL	VOLUME
CFS	2724	2106	772	385		38476.
CMS	77.	60.	22.	11.		1090.
INCHES						
MM	173.37	6.83	10.01	10.39		10.39
AC-FT	1044.	254.32	263.97	263.97		263.97
THOUS CU M	1288.	1532.	1590.	1590.		1590.
		1889.	1961.	1961.		1961.

HYDROGRAPH ROUTING
CHANNEL ROUTING-TOE OF DAM TO STN 4+00

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRY	IAME	ISTAGE	IAUTO
3	1	0	0	0	0	0	0	0
ROUTING DATA								
GLOSS	CLOSS	Avg	IRFS	ISAME	IOPF	IPMP	LSTR	
0.0	0.000	0.00	1	1	0	0	0	0
NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT	

NORMAL DEPTH CHANNEL ROUTING

	QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
	.0400	.0400	.0400	970.0	1020.0	400.	.02400

CROSS SECTION COORDINATES--STA-ELEV--ETC
 3130.00 1020.00 3280.00 1000.00 3380.00 980.00 3385.00 978.00 3450.00 977.00
 3500.00 970.00 3590.00 980.00 3530.00 1000.00

STORAGE	0.00	.51	2.05	4.83	9.68	15.06	20.90	27.17	33.89	41.06
	48.67	56.73	65.24	74.22	83.68	93.62	104.03	114.92	126.29	136.13
OUTFLOW	0.00	416.21	2642.77	6988.12	19153.91	38446.46	63477.32	94185.31	130597.13	17278.90
	220866.28	274953.54	336658.22	406106.93	482573.71	566213.01	657190.44	755677.16	861847.10	975875.40
STAGE	970.00	972.63	975.26	977.89	985.53	983.16	985.79	988.42	991.05	993.68
	996.32	998.95	1001.58	1004.21	1006.84	1009.47	1012.11	1014.74	1017.37	1020.00
FLOW	0.00	416.21	2642.77	6988.12	19153.91	38446.46	63477.32	94185.31	130597.13	17278.90
	220866.28	274953.54	336658.22	406106.93	482573.71	566213.01	657190.44	755677.16	861847.10	975875.40

STATION 3, PLAN 1, RT10 1

	OUTFLOW	1.	1.	1.	1.	1.	1.	2.	2.	2.
0.	0.	1.	1.	1.	1.	1.	1.	2.	2.	2.
2.	2.	3.	3.	3.	3.	3.	4.	4.	5.	5.
6.	7.	8.	9.	9.	10.	11.	11.	13.	14.	
17.	20.	25.	34.	47.	64.	86.	109.	132.	151.	
167.	178.	184.	187.	186.	183.	178.	172.	165.	158.	
151.	164.	140.	136.	135.	135.	136.	138.	141.	144.	
148.	153.	159.	170.	184.	203.	227.	254.	285.	317.	
350.	383.	416.	453.	496.	554.	630.	736.	1092.	1498.	
2244.	3030.	3782.	4525.	5124.	5555.	5705.	5620.	5309.	4888.	
4377.	3867.	3362.	2919.	2514.	2177.	1876.	1630.	1449.	1332.	
	S10R									
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
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0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
2.	2.	3.	3.	4.	4.	4.	4.	4.	4.	
3.	3.	3.	2.	2.	2.	2.	1.	1.	1.	

	STAGE	1.	1.	1.	1.	1.	1.	1.	1.	1.
970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0
970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0	970.0
970.0	970.0	970.0	970.1	970.1	970.1	970.1	970.1	970.1	970.1	970.1
970.1	970.1	970.2	970.2	970.3	970.4	970.5	970.7	970.8	971.0	971.0
971.1	971.1	971.2	971.2	971.2	971.2	971.2	971.1	971.1	971.0	971.0
971.1	971.1	971.2	971.2	971.2	971.2	971.2	971.1	971.1	971.0	971.0
971.0	971.0	971.0	971.0	971.0	971.0	971.0	970.9	970.9	970.9	970.9
971.0	971.0	971.0	971.1	971.1	971.1	971.1	971.1	971.1	971.0	971.0
972.2	972.2	972.4	972.6	972.7	972.7	972.8	972.9	973.0	973.4	973.9
972.8	972.8	975.5	976.0	976.4	976.8	977.0	977.1	977.1	976.9	976.6
976.3	976.0	975.7	975.4	975.1	974.7	974.4	974.1	973.9	973.7	

INCHES 14.88 21.74 22.50 24.9 24.9
 MM 377.94 552.29 571.55 571.55
 AC-FT 2276. 3327. 3443. 3443.
 THOUS CU M 2808. 4103. 4246. 4246.

MAXIMUM STORAGE =

MAXIMUM STAGE IS 977.1

STATION

3, PLAN 1, RT10 2

	OUTFLOW	OUTFLOW	OUTFLOW	OUTFLOW	OUTFLOW
0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	2.	2.
2.	3.	4.	4.	5.	5.
3.	8.	10.	13.	17.	32.
4.	84.	89.	92.	93.	92.
5.	75.	72.	70.	68.	67.
6.	74.	76.	80.	85.	92.
7.	175.	191.	208.	226.	248.
8.	609.	746.	1154.	1594.	2160.
9.	2169.	1927.	1673.	1482.	1349.
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HYDROGRAPH ROUTING

CHANNEL POSITION SIN 4400 TO 2A+00

26+00

ACROVAL DEPTH-CHANNEL ROUTING

TRANS. SECTION COORDINATES--STA., ELEV., STA., ELEV.--ETC

	1100.00	1200.00	1300.00	1400.00	1500.00	1600.00	1700.00	1800.00	1900.00	2000.00
	2000.00	2100.00	2200.00	2300.00	2400.00	2500.00	2600.00	2700.00	2800.00	2900.00
STORAGE	0.00	0.43	37.71	84.86	150.86	235.72	346.99	480.45	618.26	759.30
	903.64	1051.25	1202.14	1356.20	1512.16	1669.64	1828.62	1989.12	2151.13	2314.65
OUTFLOW	0.00	1683.10	170687.04	31508.97	67858.48	123035.62	192277.64	31989.76	471106.25	666032.53
	67693.21	1114683.07	137725.42	1666521.17	1984701.22	2326227.66	269620.97	3077507.77	3486316.96	3917359.43
STAGE	900.00	903.16	906.32	909.47	912.63	915.79	918.95	922.11	925.26	928.42
	931.58	934.74	937.89	941.05	944.21	947.37	950.53	953.68	956.84	960.00
FLOW	0.00	1683.10	10687.04	31508.97	67858.48	123035.62	192277.64	31689.76	471106.25	666032.53

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STATION 4, PLAN 1, RTIO 1

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NEW YORK STATE DEPT OF ENVIRONMENTAL CONSERVATION ALBANY F/G 13/13
NATIONAL DAM SAFETY PROGRAM. LAKE WELCH DAM (INVENTORY NUMBER N--ETC1)
SEP 80 E O'BRIEN

DACW51-79-C-0001

NL

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11. 14. 16. 18. 20. 22. 24. 26.
12. 15. 13. 12. 11. 10. 9. 8.
13. 16. 15. 12. 11. 10. 9. 8.
14. 17. 16. 15. 13. 12. 11. 10.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5702.	4591.	1674.	831.	83127.
CMS	161.	130.	47.	26.	2354.
INCHES		14.88	21.70	22.45	22.45
MM	377.96	551.18	570.30	570.30	
AC-FT	2277.	3320.	3425.	3425.	
AC-FT	2888.	3340.	4093.	4237.	4237.
THOUS CU M					

MAXIMUM STORAGE = 22.

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STATION 46 PLAN 16 81102

STAGE		STOR	
0.	0.	0.	0.
0.	0.	0.	0.
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0.	0.	0.	0.
0.	0.	0.	0.
0.	0.	0.	0.
0.	0.	0.	0.
0.	0.	0.	0.
0.	0.	0.	0.
0.	0.	0.	0.
0.	0.	0.	0.
1.	1.	1.	1.
1.	1.	1.	1.
1.	1.	1.	1.
1.	1.	1.	1.
2.	2.	2.	2.
2.	2.	2.	2.
3.	3.	3.	3.
3.	3.	3.	3.
4.	4.	4.	4.
4.	4.	4.	4.
5.	5.	5.	5.
6.	6.	6.	6.
7.	7.	7.	7.
8.	8.	8.	8.
9.	9.	9.	9.
10.	10.	10.	10.

	0	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0	6.4	6.8	7.2	7.6	8.0	8.4	8.8	9.2	9.6	10.0	10.4	10.8	11.2	11.6	12.0	12.4	12.8	13.2	13.6	14.0	14.4	14.8	15.2	15.6	16.0	16.4	16.8	17.2	17.6	18.0	18.4	18.8	19.2	19.6	20.0	20.4	20.8	21.2	21.6	22.0	22.4	22.8	23.2	23.6	24.0	24.4	24.8	25.2	25.6	26.0	26.4	26.8	27.2	27.6	28.0	28.4	28.8	29.2	29.6	30.0	30.4	30.8	31.2	31.6	32.0	32.4	32.8	33.2	33.6	34.0	34.4	34.8	35.2	35.6	36.0	36.4	36.8	37.2	37.6	38.0	38.4	38.8	39.2	39.6	40.0	40.4	40.8	41.2	41.6	42.0	42.4	42.8	43.2	43.6	44.0	44.4	44.8	45.2	45.6	46.0	46.4	46.8	47.2	47.6	48.0	48.4	48.8	49.2	49.6	50.0	50.4	50.8	51.2	51.6	52.0	52.4	52.8	53.2	53.6	54.0	54.4	54.8	55.2	55.6	56.0	56.4	56.8	57.2	57.6	58.0	58.4	58.8	59.2	59.6	60.0	60.4	60.8	61.2	61.6	62.0	62.4	62.8	63.2	63.6	64.0	64.4	64.8	65.2	65.6	66.0	66.4	66.8	67.2	67.6	68.0	68.4	68.8	69.2	69.6	70.0	70.4	70.8	71.2	71.6	72.0	72.4	72.8	73.2	73.6	74.0	74.4	74.8	75.2	75.6	76.0	76.4	76.8	77.2	77.6	78.0	78.4	78.8	79.2	79.6	80.0	80.4	80.8	81.2	81.6	82.0	82.4	82.8	83.2	83.6	84.0	84.4	84.8	85.2	85.6	86.0	86.4	86.8	87.2	87.6	88.0	88.4	88.8	89.2	89.6	90.0	90.4	90.8	91.2	91.6	92.0	92.4	92.8	93.2	93.6	94.0	94.4	94.8	95.2	95.6	96.0	96.4	96.8	97.2	97.6	98.0	98.4	98.8	99.2	99.6	100.0	100.4	100.8	101.2	101.6	102.0	102.4	102.8	103.2	103.6	104.0	104.4	104.8	105.2	105.6	106.0	106.4	106.8	107.2	107.6	108.0	108.4	108.8	109.2	109.6	110.0	110.4	110.8	111.2	111.6	112.0	112.4	112.8	113.2	113.6	114.0	114.4	114.8	115.2	115.6	116.0	116.4	116.8	117.2	117.6	118.0	118.4	118.8	119.2	119.6	120.0	120.4	120.8	121.2	121.6	122.0	122.4	122.8	123.2	123.6	124.0	124.4	124.8	125.2	125.6	126.0	126.4	126.8	127.2	127.6	128.0	128.4	128.8	129.2	129.6	130.0	130.4	130.8	131.2	131.6	132.0	132.4	132.8	133.2	133.6	134.0	134.4	134.8	135.2	135.6	136.0	136.4	136.8	137.2	137.6	138.0	138.4	138.8	139.2	139.6	140.0	140.4	140.8	141.2	141.6	142.0	142.4	142.8	143.2	143.6	144.0	144.4	144.8	145.2	145.6	146.0	146.4	146.8	147.2	147.6	148.0	148.4	148.8	149.2	149.6	150.0	150.4	150.8	151.2	151.6	152.0	152.4	152.8	153.2	153.6	154.0	154.4	154.8	155.2	155.6	156.0	156.4	156.8	157.2	157.6	158.0	158.4	158.8	159.2	159.6	160.0	160.4	160.8	161.2	161.6	162.0	162.4	162.8	163.2	163.6	164.0	164.4	164.8	165.2	165.6	166.0	166.4	166.8	167.2	167.6	168.0	168.4	168.8	169.2	169.6	170.0	170.4	170.8	171.2	171.6	172.0	172.4	172.8	173.2	173.6	174.0	174.4	174.8	175.2	175.6	176.0	176.4	176.8	177.2	177.6	178.0	178.4	178.8	179.2	179.6	180.0	180.4	180.8	181.2	181.6	182.0	182.4	182.8	183.2	183.6	184.0	184.4	184.8	185.2	185.6	186.0	186.4	186.8	187.2	187.6	188.0	188.4	188.8	189.2	189.6	190.0	190.4	190.8	191.2	191.6	192.0	192.4	192.8	193.2	193.6	194.0	194.4	194.8	195.2	195.6	196.0	196.4	196.8	197.2	197.6	198.0	198.4	198.8	199.2	199.6	200.0	200.4	200.8	201.2	201.6	202.0	202.4	202.8	203.2	203.6	204.0	204.4	204.8	205.2	205.6	206.0	206.4	206.8	207.2	207.6	208.0	208.4	208.8	209.2	209.6	210.0	210.4	210.8	211.2	211.6	212.0	212.4	212.8	213.2	213.6	214.0	214.4	214.8	215.2	215.6	216.0	216.4	216.8	217.2	217.6	218.0	218.4	218.8	219.2	219.6	220.0	220.4	220.8	221.2	221.6	222.0	222.4	222.8	223.2	223.6	224.0	224.4	224.8	225.2	225.6	226.0	226.4	226.8	227.2	227.6	228.0	228.4	228.8	229.2	229.6	230.0	230.4	230.8	231.2	231.6	232.0	232.4	232.8	233.2	233.6	234.0	234.4	234.8	235.2	235.6	236.0	236.4	236.8	237.2	237.6	238.0	238.4	238.8	239.2	239.6	240.0	240.4	240.8	241.2	241.6	242.0	242.4	242.8	243.2	243.6	244.0	244.4	244.8	245.2	245.6	246.0	246.4	246.8	247.2	247.6	248.0	248.4	248.8	249.2	249.6	250.0	250.4	250.8	251.2	251.6	252.0	252.4	252.8	253.2	253.6	254.0	254.4	254.8	255.2	255.6	256.0	256.4	256.8	257.2	257.6	258.0	258.4	258.8	259.2	259.6	260.0	260.4	260.8	261.2	261.6	262.0	262.4	262.8	263.2	263.6	264.0	264.4	264.8	265.2	265.6	266.0	266.4	266.8	267.2	267.6	268.0	268.4	268.8	269.2	269.6	270.0	270.4	270.8	271.2	271.6	272.0	272.4	272.8	273.2	273.6	274.0	274.4	274.8	275.2	275.6	276.0	276.4	276.8	277.2	277.6	278.0	278.4	278.8	279.2	279.6	280.0	280.4	280.8	281.2	281.6	282.0	282.4	282.8	283.2	283.6	284.0	284.4	284.8	285.2	285.6	286.0	286.4	286.8	287.2	287.6	288.0	288.4	288.8	289.2	289.6	290.0	290.4	290.8	291.2	291.6	292.0	292.4	292.8	293.2	293.6	294.0	294.4	294.8	295.2	295.6	296.0	296.4	296.8	297.2	297.6	298.0	298.4	298.8	299.2	299.6	300.0	300.4	300.8	301.2	301.6	302.0	302.4	302.8	303.2	303.6	304.0	304.4	304.8	305.2	305.6	306.0	306.4	306.8	307.2	307.6	308.0	308.4	308.8	309.2	309.6	310.0	310.4	310.8	311.2	311.6	312.0	312.4	312.8	313.2	313.6	314.0	314.4	314.8	315.2	315.6	316.0	316.4	316.8	317.2	317.6	318.0	318.4	318.8	319.2	319.6	320.0	320.4	320.8	321.2	321.6	322.0	322.4	322.8	323.2	323.6	324.0	324.4	324.8	325.2	325.6	326.0	326.4	326.8	327.2	327.6	328.0	328.4	328.8	329.2	329.6	330.0	330.4	330.8	331.2	331.6	332.0	332.4	332.8	333.2	333.6	334.0	334.4	334.8	335.2	335.6	336.0	336.4	336.8	337.2	337.6	338.0	338.4	338.8	339.2	339.6	340.0	340.4	340.8	341.2	341.6	342.0	342.4	342.8	343.2	343.6	344.0	344.4	344.8	345.2	345.6	346.0	346.4	346.8	347.2	347.6	348.0	348.4	348.8	349.2	349.6	350.0	350.4	350.8	351.2	351.6	352.0	352.4	352.8	353.2	353.6	354.0	354.4	354.8	355.2	355.6	356.0	356.4	356.8	357.2	357.6	358.0	358.4	358.8	359.2	359.6	360.0	360.4	360.8	361.2	361.6	362.0	362.4	362.8	363.2	363.6	364.0	364.4	364.8	365.2	365.6	366.0	366.4	366.8	367.2	367.6	368.0	368.4	368.8	369.2	369.6	370.0	370.4	370.8	371.2	371.6	372.0	372.4	372.8	373.2	373.6	374.0	374.4	374.8	375.2	375.6	376.0	376.4	376.8	377.2	377.6	378.0	378.4	378.8	379.2	379.6	380.0	380.4	380.8	381.2	381.6	382.0	382.4	382.8	383.2	383.6	384.0	384.4	384.8	385.2	385.6	386.0	386.4	386.8	387.2	387.6	388.0	388.4	388.8	389.2	389.6	390.0	390.4	390.8	391.2	391.6	392.0	392.4	392.8	393.2	393.6	394.0	394.4	394.8	395.2	395.6	396.0	396.4	396.8	397.2	397.6	398.0	398.4	398.8	399.2	399.6	400.0	400.4	400.8	401.2	401.6	402.0	402.4	402.8	403.2	403.6	404.0	404.4	404.8	405.2	405.6	406.0	406.4	406.8	407.2	407.6	408.0	408.4	408.8	409.2	409.6	410.0	410.4	410.8	411.2	411.6	412.0	412.4	412.8	413.2	413.6	414.0	414.4	414.8	415.2	415.6	416.0	416.4	416.8	417.2	417.6	418.0	418.4	418.8	419.2	419.6	420.0	420.4	420.8	421.2	421.6	422.0	422.4	422.8	423.2	423.6	424.0	424.4	424.8	425.2	425.6	426.0	426.4	426.8	427.2	427.6	428.0	428.4	428.8	429.2	429.6	430.0	430.4	430.8	431.2	431.6	432.0	432.4	432.8	433.2	433.6	434.0	434.4	434.8	435.2	435.6	436.0	436.4	436.8	437.2	437.6	438.0	438.4	438.8	439.2	439.6	440.0	440.4	440.8	441.2	441.6	442.0	442.4	442.8	443.2	443.6	444.0	444.4	444.8	445.2	445.6	446.0	446.4	446.8	447.2	447.6	448.0	448.4	4
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 0. 1. 1. 1. 1. 1. 1.
 2. 3. 4. 5. 6. 7. 8.
 7. 7. 6. 5. 4. 3. 2.

			STAGE			
640.0	640.0	640.0	640.0	640.0	640.0	640.0
640.0	640.0	640.0	640.0	640.0	640.0	640.0
640.0	640.0	640.0	640.0	640.0	640.0	640.0
640.0	640.0	640.0	640.0	640.0	640.0	640.0
640.0	640.0	640.0	640.1	640.1	640.1	640.2
640.3	640.3	640.3	640.3	640.3	640.3	640.3
640.3	640.2	640.2	640.2	640.2	640.2	640.2
640.3	640.3	640.3	640.3	640.3	640.3	640.3
640.6	640.6	640.7	640.7	640.8	640.9	640.5
641.9	641.4	643.4	644.4	644.7	645.0	641.4
644.8	645.6	646.5	646.6	646.3	643.8	643.0

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2738.	2103.	768.	383.	38272.
CMS	78.	60.	22.	11.	1084.
INCHES		6.82	9.96	10.34	10.34
MM		173.15	253.06	262.57	262.57
AC-FT		1043.	1524.	1581.	1581.
THOUS CU M		1286.	1880.	1951.	1951.

MAXIMUM STORAGE = 8.

MAXIMUM STAGE IS 645.1

HYDROGRAPH ROUTING

CHANNEL ROUTING STN 52+00 TO 76+00

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPT	INAME	ISTAGE	IAUTO	LSTR
6	1	0	0	0	0	0	0	0	
GLOSS	CLOSS	Avg	ROUTING DATA						
0.0	0.000	0.00	IRRES ISAME	IOPF	IPMP				
			1	1	0				
NSTPS	NSTDL	LAG	AMSKR	X	TSK	STORA	ISPRAT		
1	0	0	0.000	0.000	0.000	0.000	0.000		

NORMAL DEPTH CHANNEL ROUTING

ON(1)	ON(2)	ON(3)	ELNUT	ELMAX	RINTH	SEL
-0.00	.0400	.0400	480.0	540.0	2400.	.06700

COORDINATES—STATE ELEV.—STAFF ELEV.—ETC,
SECTION 547-00 546-00 545-00 544-00 543-00
542-00 541-00 540-00 539-00 538-00
537-00 536-00 535-00 534-00 533-00
532-00 531-00 530-00 529-00 528-00
527-00 526-00 525-00 524-00 523-00
522-00 521-00 520-00 519-00 518-00
517-00 516-00 515-00 514-00 513-00
512-00 511-00 510-00 509-00 508-00
507-00 506-00 505-00 504-00 503-00
502-00 501-00 500-00 499-00 498-00
497-00 496-00 495-00 494-00 493-00
492-00 491-00 490-00 489-00 488-00
487-00 486-00 485-00 484-00 483-00
482-00 481-00 480-00 479-00 478-00
477-00 476-00 475-00 474-00 473-00
472-00 471-00 470-00 469-00 468-00
467-00 466-00 465-00 464-00 463-00
462-00 461-00 460-00 459-00 458-00
457-00 456-00 455-00 454-00 453-00
452-00 451-00 450-00 449-00 448-00
447-00 446-00 445-00 444-00 443-00
442-00 441-00 440-00 439-00 438-00
437-00 436-00 435-00 434-00 433-00
432-00 431-00 430-00 429-00 428-00
427-00 426-00 425-00 424-00 423-00
422-00 421-00 420-00 419-00 418-00
417-00 416-00 415-00 414-00 413-00
412-00 411-00 410-00 409-00 408-00
407-00 406-00 405-00 404-00 403-00
402-00 401-00 400-00 399-00 398-00
397-00 396-00 395-00 394-00 393-00
392-00 391-00 390-00 389-00 388-00
387-00 386-00 385-00 384-00 383-00
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372-00 371-00 370-00 369-00 368-00
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332-00 331-00 330-00 329-00 328-00
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322-00 321-00 320-00 319-00 318-00
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307-00 306-00 305-00 304-00 303-00
302-00 301-00 300-00 299-00 298-00
297-00 296-00 295-00 294-00 293-00
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252-00 251-00 250-00 249-00 248-00
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232-00 231-00 230-00 229-00 228-00
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67-00 66-00 65-00 64-00 63-00
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52-00 51-00 50-00 49-00 48-00
47-00 46-00 45-00 44-00 43-00
42-00 41-00 40-00 39-00 38-00
37-00 36-00 35-00 34-00 33-00
32-00 31-00 30-00 29-00 28-00
27-00 26-00 25-00 24-00 23-00
22-00 21-00 20-00 19-00 18-00
17-00 16-00 15-00 14-00 13-00
12-00 11-00 10-00 9-00 8-00
7-00 6-00 5-00 4-00 3-00
2-00 1-00 0-00

STORAGE	0.00	5.77	23.08	51.92	92.31	144.23	207.69	280.85	357.87	445.97
STORAGE	538.93	636.05	777.33	842.69	951.12	1062.28	1176.20	1292.87	1412.28	1534.46
OUTFLOW	0.00	1363.34	8656.65	25522.70	54966.31	99660.56	162059.06	255947.23	375903.16	522135.99
OUTFLOW	692422.34	885908.32	1102435.60	1343052.22	1609082.31	1898412.13	2210857.70	256317.82	2904749.37	3286151.99
STAGE	480.00	483.16	486.32	489.47	492.63	495.79	498.95	502.11	505.26	508.42
STAGE	511.58	514.74	517.89	521.05	524.21	527.37	530.53	533.68	536.84	540.00
FLOW	0.00	1363.34	8656.65	25522.70	54966.31	99660.56	162059.06	255947.23	375903.16	522135.99
FLOW	692422.34	885908.32	1102435.60	1343052.22	1609082.31	1898412.13	2210857.70	256317.82	2904749.37	3286151.99

STATION 6, PLAN 1, RTIO 1

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STAGE	PEAK			6-HOUR			24-HOUR			72-HOUR			TOTAL VOLUME		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0
482.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0
483.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0
484.0	480.1	480.1	480.1	480.1	480.1	480.1	480.1	480.1	480.1	480.1	480.1	480.1	480.1	480.1	480.1
485.0	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4
486.0	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4
487.0	480.3	480.3	480.3	480.3	480.3	480.3	480.3	480.3	480.3	480.3	480.3	480.3	480.3	480.3	480.3
488.0	480.3	480.3	480.3	480.4	480.4	480.4	480.4	480.4	480.4	480.5	480.5	480.5	480.6	480.6	480.7
489.0	480.9	480.9	480.9	481.0	481.0	481.0	481.1	481.1	481.1	481.4	481.4	481.6	482.6	482.6	483.2
490.0	483.8	483.8	484.0	484.5	484.5	484.7	484.7	484.7	484.9	485.0	485.0	485.0	485.0	485.0	485.0
491.0	484.3	484.3	484.3	484.1	483.9	483.7	483.5	483.5	483.5	483.4	483.4	483.4	483.3	483.3	483.1

CMSS 162. 130. 47. 62. 23. 2346.

THESES	14.88	21.64	22.38	22.38
MIN	377.91	549.56	568.49	568.49
MAX	227.91	331.05	342.4	342.4

MAXIMUM STORAGE = 11

MANUFACTURE STAGE IS 485.0

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STATION		OUTFLOW						STOR					
T.	O.	0.	0.	0.	1.	1.	1.	0.	0.	0.	0.	0.	0.
1.	0.	0.	0.	0.	2.	2.	2.	0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	1.	4.	4.	4.	5.	5.	5.	5.	5.	5.
3.	3.	3.	3.	3.	4.	4.	4.	5.	5.	5.	5.	5.	5.
8.	9.	12.	15.	21.	29.	39.	51.	62.	73.	84.	80.	80.	80.
81.	87.	91.	93.	93.	92.	90.	87.	84.	80.	80.	80.	80.	80.
76.	73.	71.	69.	68.	67.	68.	69.	70.	72.	72.	72.	72.	72.
73.	75.	78.	83.	89.	98.	109.	122.	137.	153.	153.	153.	153.	153.
169.	186.	202.	220.	240.	266.	301.	347.	406.	481.	481.	481.	481.	481.
574.	696.	986.	1473.	2011.	2422.	2699.	2730.	2645.	2447.	2447.	2447.	2447.	2447.
2229.	1963.	1728.	1521.	1381.	1266.	1149.	1026.	918.	816.	816.	816.	816.	816.

P.EAK 6-HOUR 24-HOUR 72-HOUR

CFS	270.	2105.	767.	382.	38189.
CMS	77.	60.	22.	11.	1081.
HES		6.82	9.94	10.31	10.31
MH		173.27	252.53	262.00	262.00
-FT		1044.	1521.	1578.	1578.
M		1287.	1874.	1944.	1974.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION STATION AREA PLAN RATIO 1 RATIO 2 RATIOS APPLIED TO FLOWS

HYDROGRAPH AT	1	2.87	1	6769.	3085.
ROUTED TO	2	2.87	1	174.70)(87.35)(
ROUTED TO	3	2.87	1	5711.	2726.
ROUTED TO	4	2.87	1	161.72)(77.15)(
ROUTED TO	5	2.87	1	5205.	2732.
ROUTED TO	6	2.87	1	165.54)(77.26)(
ROUTED TO	5	2.87	1	5702.	2738.
ROUTED TO	6	2.87	1	161.62)(77.54)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1		INITIAL ELEVATION	SPILLWAY CREST VALUE	TOP OF DAM
RATIO OF RESERVOIR N.S.ELEV	STORAGE OUTFLOW	1015.00 4454. 0.	1015.00 4454. 0.	1016.30 4766. 633.
MAXIMUM RESERVOIR DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION HOURS	TIME OF FAILURE HOURS
1.00 1018.41	2.11	5244. 5n04.	5711. 2724.	11.50 9.50
.50 1017.41	1.11			43.50 44.00
				0.00 0.00
PLAN 1 STATION 3				
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME	
1.00 .50	5705. 2732.	977.1 975.3	43.50 44.00	
PLAN 1 STATION 4				
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME	
1.00 .50	5702. 2738.	904.6 903.5	43.50 44.00	
PLAN 1 STATION 5				
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME	
1.00 .50	5708. 2738.	647.0 645.1	43.50 44.00	
PLAN 1 STATION 6				
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME	
1.00 .50	5710. 2730.	485.0 483.7	43.50 44.00	

STABILITY ANALYSIS

APPENDIX E

Job No. 1511

TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS
NEW YORK

Sheet 1 of 11

Project PHASE I DAM INSPECTION

Date 6/11/80

Subject DAM STABILITY ANALYSIS

By JP

LAKE WELCH

Chk. by

Assumptions :

- 1.) The unit weight of concrete is assumed to be 145 lbs/cu.ft.
- 2) Ice load of 5000 lbs/sq.ft acting about 1 foot from top of dam. (according to Corps of Engineers criteria)
- 3) Angle of internal resistance of rock is assumed to be 45° based on visual examinations of the exposed rock at downstream toe and its bedding planes.

- a) Dam site is Seismic zone 2

6.

LOADING CONDITIONS

Case I Normal loading; Lake level at Spillway crest EL 1015.0, no ice load.

Case II Normal loading; Lake level at Spillway crest EL 1015.0, with ice load.

Case III Unusual loading; Lake level at $\frac{1}{2}$ PAIF

Case IV Extreme loading; Lake level at PAIF

Case V Unusual loading; Lake level at Fullwater crest and earthquake forces of 0.05g.

Job No. 1511

TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS

NEW YORK

Project

Phase 1 Inspection

Subject

Dam Stability Analysis

Sheet 2 of 11

Date 6/1/82

By JP

Chk. by _____

STABILITY CRITERIA:

The stability criteria against overturning and sliding were evaluated as follows.

Overturning - Stability is considered adequate if the resultant of all forces falls within the middle third of the base under the normal loading condition and within middle half of the base under the unusual and extreme loading conditions.

Sliding - Stability along the base of the structure is evaluated using the friction factor of safety (FFS) which is equal to $\sqrt{\tan\phi/H}$, where V is the sum of vertical forces acting on the base, H is the sum of all horizontal forces and $\tan\phi$ is Friction Factor. The stability with respect to sliding is considered adequate if the FFS exceeds 1.50 under normal loading conditions, 1.25 under unusual loading conditions and 1.1 under extreme loading conditions.

Job No. 1511

TIPPETTS-ABBETT-MCCARTHY-STRATTON
ENGINEERS AND ARCHITECTS

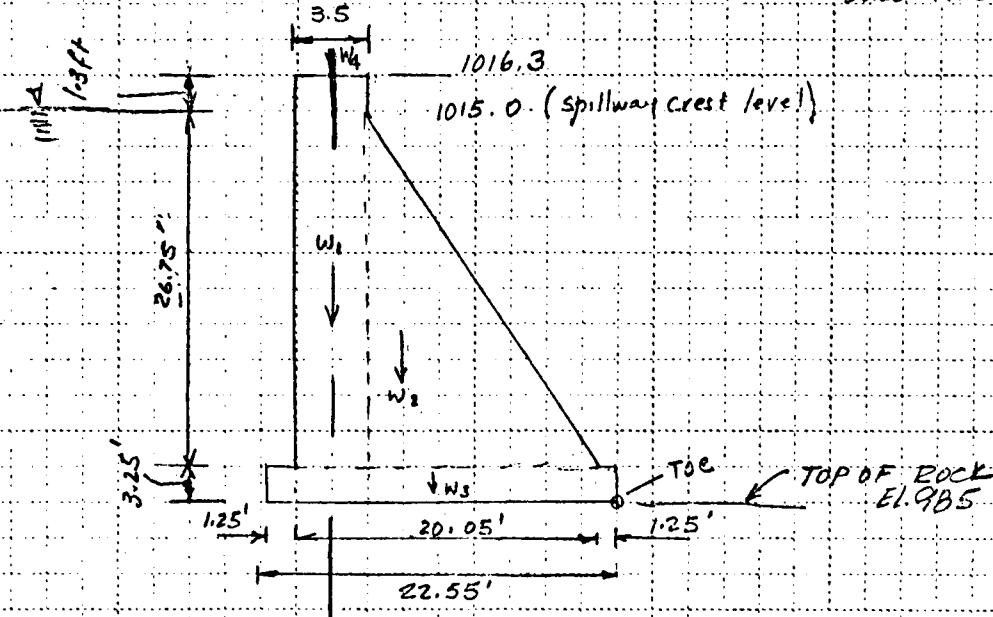
NEW YORK

Project Phase I Dam Inspection

Subject

Sheet 3 of 11
Date 6/1/83
By JP
Chk. byDEAD LOADS

Scale: NTS

 $\Sigma M @ \text{Toe}$

$$W_1 = 0.145 \times 3.5 \times 28.05 = 14.23 \times 19.55 = 278.2 \text{ kF}$$

$$W_2 = 0.145 \times \frac{1}{2} \times 16.55 \times 26.75 = 32.09 \times 12.28 = 394.1 \text{ kF}$$

$$W_3 = 0.145 \times \frac{1}{2} \times 22.55 = 10.63 \times 11.28 = 119.9 \text{ kF}$$

$$F_V = 56.95 \quad M_e = 792.2 \text{ kF} \quad \bar{x} = 13.91$$

$$14.23 \times 17.28 = 245.9$$

$$32.09 \times 12.17 = 390.5$$

$$10.63 \times 1.63 = 17.3$$

$$F_V = 56.95 \quad M_e = 653.7 \quad \bar{y} = 11.47'$$

 $\Sigma M_R @ \text{Toe}$ due to Rock Bolt

$$W_4 = \frac{50000 \text{ #}}{10^4} = 5000 \text{ #/LF}$$

$$F_V = 5 \text{ kF}$$

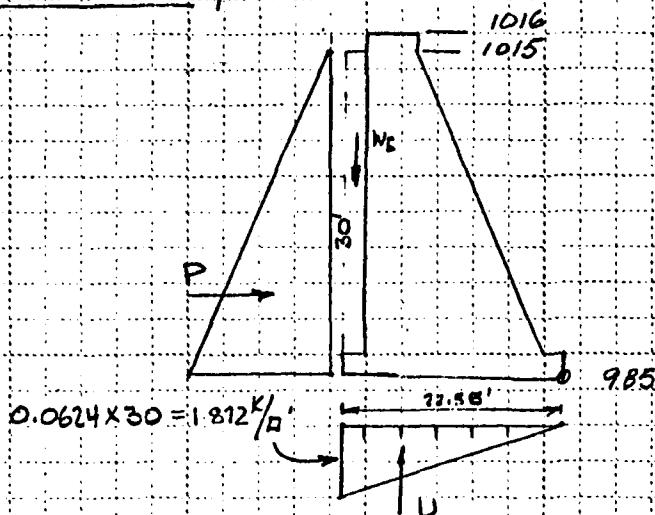
$$M_e = 5 \times 19.55 = 97.75 \text{ kF}$$

Job No. 1511

TIPPETTS-ABBETT-MCCARTHY-STRATTON
ENGINEERS AND ARCHITECTS NEW YORK

Project PHASE 1 DAM INSPECTION

Subject

Sheet 4 of 11
Date 6/1/80
By JP
Chk. byHYDROSTATIC FORCESa. NORMAL LOADING; WL at El. 1015. $\Sigma M @ \text{Toe}$

$$P = \frac{1}{2} \times 1.812 \times 30 = 28.08 \times 10 = 280.8 \text{ kF}$$

$$U = \frac{1}{2} \times 1.812 \times 22.55 = -21.11 \times 15.03 = 317.28 \text{ kF}$$

$$W_s = 0.0624 \times 1.25 \times 26.75 = \frac{2.09 \times 21.93}{598.08} = 45.83 \text{ kF}$$

$$F_v = -19.02 \text{ kF}$$

$$F_h = 28.08 \text{ kF}$$

$$N_r = 45.83 \text{ kF}$$

$$N_o = 598.08 \text{ kF}$$

Job No. 151

TIPPETTS-ABBETT-MCCARTHY-STRATTON
ENGINEERS AND ARCHITECTS NEW YORK

Sheet 5 of 11

Project

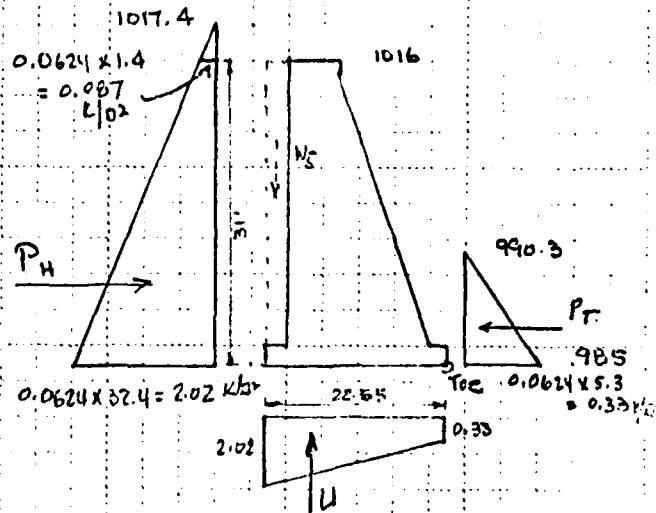
PHASE I DAM INSPECTION

Date 6/14/82

Subject

By J.P.

Chk. by

Maximum Loading: 1/2 PMF WL @ El. 1017.4; tailwater
El. 990.3 $\Sigma M @ \text{Toe}$

$$P_H = \frac{[0.087 + 2.02]31}{2} = 32.65 \rightarrow K_F = 351.3$$

$$P_T = \left(\frac{1}{2} \times 0.33 \times 5.3 \right) 0.6 = 0.52 \leftarrow K_F = 0.9$$

$$U = \frac{(0.33 + 2.02) 22.55}{2} = -26.50 \uparrow \times 13.98 = 370.47$$

60% tailwater
pressure

$$W_S = 0.0624 \times 1.25 \times 27.75 = 2.16 \downarrow \times 21.93$$

47.371

$$\begin{aligned} F_V &= -24.34 \uparrow \\ F_H &= 32.13 \rightarrow \\ M_R &= 48.27 \text{ kF} \\ M_O &= 721.77 \text{ kF} \end{aligned}$$

Job No. 1511
Project
Subject

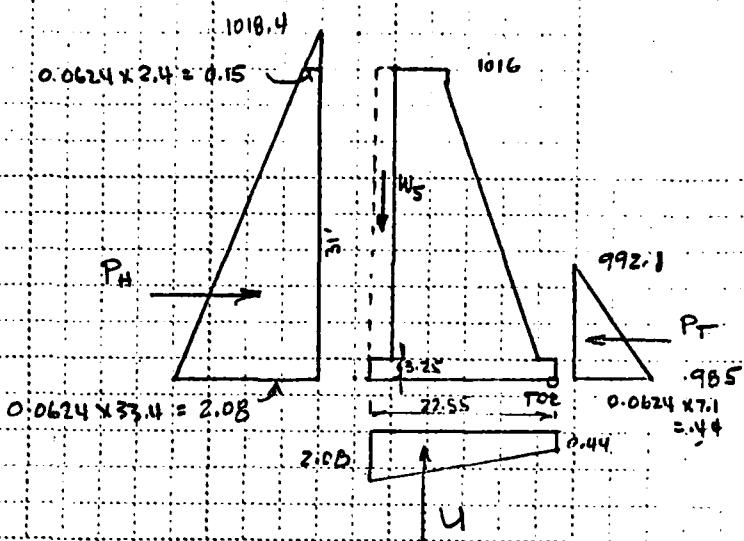
**TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS** NEW YORK

Sheet 6 of 11
Date 6/1/80
By JP
Chk. by _____

PHASE I D&I INSPECTION

Subject

Maximum loading : PMF WL @ 1018.4 ; full water El. 992.1.



E.M. @ Toe

$$P_H \times [0.15 + 2.08]_{31} = 34.57 \times 11.0 = 380.27$$

$$U = \left[\frac{0.44 + 2.08}{2} \right] 22.55 = 28.41 \times 13.72 \quad \pm \quad 389.79$$

$$P_T = \frac{1}{2} [0.44 \times 7.1] \cdot 0.6 = 0.93 \times 2.37 = 2.20$$

$$W_5 = 0.0624 \times 1.25 \times 27.75 = 2.14 \times 21.93$$

47.37

$$\begin{array}{l} F_V = -26.25^K \uparrow \\ F_H \rightarrow 33.64^K \rightarrow \\ M_Z 49.57^K_F \\ M_0 770.06 \end{array}$$

Job No. 1511

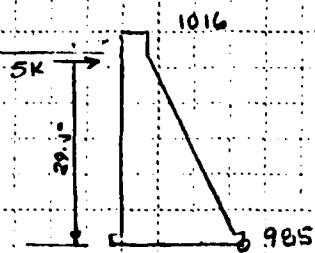
TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS

NEW YORK

Project PHASE I INSPECTION -
Subject DAM STABILITYSheet 7 of 11
Date 6/11/80
By JP
Chk. byICE LOAD

EM @ Toe

$$50 \times 29.5 = 147.50 \text{ KF}$$

CASE I NORMAL LOADING - WITHOUT ICE

	Fv	Fh	Mx	Mo
Dead load	56.95	0.0	792.2	0
Hydrostatic	-19.02	28.08	45.93	598.08
Rock Bolt	5.00	0	97.75	0
	42.93	28.08	935.78	598.08

$$\Sigma M = 935.78 - 598.1 = 337.68 \text{ KF}$$

$$e = \frac{22.55}{2} - \frac{337.68}{42.93} = 11.28 - 7.87 = 3.41 \text{ ' downstream from base of } \text{Toe}$$

Resultant Location

$$\frac{337.68}{42.93} - \frac{22.55}{5} = 7.87 - 7.52 = 0.35 \text{ ' inside middle third. OK}$$

$$P : \frac{42.93}{22.55} \left(1 + \frac{6 \times 3.41}{22.55} \right) \times \frac{1000}{144} = 13 \pm 12 \quad \left\{ \begin{array}{l} 25.91 @ \text{Toe} \\ 1 @ \text{Heel.} \\ \text{OK} \end{array} \right.$$

Friction factor of Safety

$$FFS = \frac{42.93 \times \tan 45^\circ}{28.08} = 1.53 \text{ OK}$$

Job No. 1511

TIPPETTS-ABBETT-MCCARTHY-STRATTON
ENGINEERS AND ARCHITECTS NEW YORK

Sheet 8 of 11

Project PHASE I DAM INSPECTION

Date 6/1/82

Subject DAM STABILITY ANALYSIS

By JC

Chk. by _____

CASE II NORMAL LOADING WITH ICE LOAD

	F _V	F _H	M _R	M _O
Dead load	56.95	0.0	792.2	
Hydrostatic	-19.02	28.08	45.93	598.08
Rock Bolt	5.0	0	97.75	0
Ice load		5.0		147.50
	42.93	33.08	935.78	745.58

$\Sigma M = 935.78 - 745.58 = 190.2$

$c = \frac{22.55}{2} - \frac{190.2}{42.93} = 11.28 - 4.43 = 6.85'$ downstream from base. ↗

Resultant location : $\frac{190.2}{42.93} - \frac{22.55}{3} = 4.43 - 7.52 = -3.09'$ but side middle third.

P : $\frac{42.93}{22.55} \left(1 + \frac{6 \times 6.85}{22.55} \right) \times \frac{1000}{144} = 13 \pm 24$ 37 psi @ Toe
+11 psi @ Heel

Friction Factor of Safety

FFS = $\frac{42.93 \times \tan 45^\circ}{33.08} = 1.30$

For resultant to lie within middle third, the additional force the rock bolt would be subject = V

$7.52 = \frac{190.2 + 19.55V}{42.93 + V}$

$322.83 + 7.52V = 190.2 + 19.55V$

$V = 11.0 \text{ kips}$

$50.0 + 11.0 = 61.0 \text{ kips} \quad \text{((Max Ultimate Load \approx 75 kips))}$ OK

Job No. 1511

TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS NEW YORK

Project PHASE I DAM INSPECTION

Sheet 9 of 11

Subject DAM SIZABILITY ANALYSIS

Date 6/1/81

By JP

Chk. by

Case III 1/2 PMF

	F _v	F _H	M _e	M _o
Dead load :	56.95	0.0	792.2	0
Hydrostatic :	-24.34	32.13	48.27	721.77
Rock bolt :	5.0	0	97.75	0
	37.61	32.13	938.22	721.77

$$\Sigma M = 938.22 - 721.77 = 216.45$$

$$e = \frac{22.55}{2} - \frac{216.45}{37.61} = 11.28 - 5.76 = 5.52' \text{ downstream from base \&}$$

Resultant Location: $\frac{216.45}{37.61} - \frac{22.55}{3} = 5.76 - 7.52 = -1.76'$ out side middle flnd.

$$P = \frac{37.61}{22.55} \left(1 \pm \frac{6 \times 5.52}{22.55} \right) \times \frac{1000}{144} = 12 \pm 17 \quad 29 \text{ psi @ toe} \\ -5 \text{ psi @ heel.}$$

JK

Friction Factor of Safety

$$FFS = \frac{37.61}{32.13} \tan 45^\circ = 1.17$$

CASE IV PMF

	F _v	F _H	M _e	M _o
Dead load :	56.95	0.0	792.2	0
Hydrostatic :	-26.25	33.64	49.57	770.06
Rock bolt :	5.0	0	97.15	0
	35.70	33.64	939.52	770.06

$$\Sigma M = 939.52 - 770.06 = 169.46 \text{ kF}$$

$$e = \frac{22.55}{2} - \frac{169.46}{35.70} = 11.28 - 4.75 = 6.53' \text{ downstream from base \&}$$

Job No. 1511

TIPPETTS-ABBETT-MCCARTHY-STRATTON
ENGINEERS AND ARCHITECTS NEW YORK

Sheet 10 of 11

Project PHASE I DAM INSPECTION

Date 6/1/62

Subject DAM STABILITY ANALYSIS

By J.P.

Chk. by _____

PMF - Continued

$$\text{Resultant location} : \frac{169.46}{35.70} - \frac{22.55}{3} = 4.75 - 7.52E-2.77' \text{ outside middle third}$$

$$f = \frac{35.70}{22.55} \left[1 + \frac{6 \times 6.53}{22.55} \right] \times \frac{1000}{144} = 11 \pm 19 \quad 30 \text{ psi @ Toe} \\ - 8 \text{ psi @ heel}$$

FRICTION FACTOR OF SAFETY

$$FFS = \frac{35.70 \tan 45^\circ}{33.64} = 1.06$$

CASE IV ; Normal loading with Earthquake. Reservoir level at El. 1015'

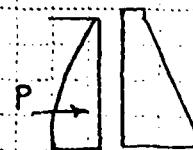
Zone 2 : 0.05

Zangers Method ; $C = 0.726$ when $\theta = 0^\circ$

(1) Hydrodynamic Forces :

$$P = 0.726 \times 0.05 \times 0.0624 \times 30^2 = 2.03 \text{ kips}$$

$$M_p = 2.03 \{ 0.4 \times 30 \} = 24.36 \text{ kip}$$



(2) Dynamic Forces

$$W_D = 0.05(56.95) = 2.85 \text{ k}$$

$$M_{WD} = 2.85 \times \bar{y} = 2.85 \times 11.47 = 32.69 \text{ kip}$$

Job No. 1511TIPPETTS-ABBETT-MCCARTHY-STRATTON
ENGINEERS AND ARCHITECTS NEW YORKProject PHASE I DAM INSPECTION
Subject DAM STABILITY ANALYSISSheet 11 of 11
Date 6/11/80
By J.P.
Chk. by _____

	F_v	F_H	M_R	M_o
Dead Load	5695	0.0	792.2	
Hydrostatic	-19.02	28.08	45.83	598.08
Rock Bolt	5.0	0	97.75	0
Earthquakes	Hydrodynamic		24.36	
	Dynamic	2.03		32.69
	2.85			
	42.93	32.96	935.78	655.13

$$\Sigma M = 935.78 - 655.13 = 280.65$$

Resultant Location

$$\frac{280.65}{42.93} - \frac{27.55}{3} = 6.54 - 7.52 = -0.98' \text{ outside Middle third}$$

$$z = \frac{22.55}{2} - 6.54 = 11.28 - 6.54 = 4.74' \text{ downstream from base \&}$$

$$p = \frac{42.93}{22.55} \left(1 \pm \frac{6 \times 4.74}{22.55} \right) \frac{1000}{144} = 13 \pm 17 \quad 30 \text{ psi @ Toe} \\ - 4 \text{ psi @ Heel}$$

FRICITION FACTOR OF SAFETY

$$FFS = \frac{42.93 \tan 45^\circ}{32.96} = 1.30$$

OTHER DATA:

- (1) AVAILABLE STABILITY ANALYSIS
- (2) CORRESPONDENCE BETWEEN OWNER
AND ENGINEER DURING 1978-79
REPAIRS

APPENDIX F

April 3, 1978

3308-001-1

**Stability Analysis of the
Lake Welch Gravity Dam**

The Lake Welch Dam was analyzed for both sliding and overturning stability. Three conditions of loading were considered:

Case I Normal condition of dead hydrostatic forces, including uplift.

Case II Extreme condition of normal loading plus ice forces of 3,000 pounds per lineal foot.

Case III Extreme condition of normal loading plus earthquake forces of 0.05g.

The analysis showed that the ratio of the horizontal forces tending to cause sliding to the vertical forces are, for the three conditions respectively, 0.78, 0.86 and 0.97. While there are no codes, or universally accepted standards, mandating the design of gravity dams, these values are somewhat higher than modern practice would dictate.

The analysis showed further that the corresponding ratios of moments resisting overturning to the moments tending to cause overturning are 1.36, 1.18 and 1.18. These values are lower than considered prudent in modern practice.

These figures indicate that, while not in accordance with today's thinking, the dam is not approaching the point of incipient failure from either sliding or overturning. The factors found for Case I are conservative as the uplift forces applied in the analysis were determined in an accepted and conservative manner. Effects of ice in Case II can be mitigated to any degree desired by drawing down the lake in winter, either fully or partially. Regarding Case III, there has been little seismic activity in this area.

MAIN

Chen Palisades Interstate Park Commission Job No. 3308-1 Sheet 1 of 16
 Subject Lake Welsh Dam Repairs By P.P.C. Date 3/31/72
Dam Stability Analysis Chd. Rev.

Loading Combinations - Dam in Present Condition

Case I (Normal)	Dead Load & Hydrostatic
Case II (Extreme)	" " "
Case III (Extreme)	" " " { Seismic & Ice

Loading Combination - Reinforcement Added

Case IV (Normal)	Case I & Reinforcement
Case V (Extreme)	Case II & "
Case VI (Extreme)	Case III & "

Criteria for Analysis Results

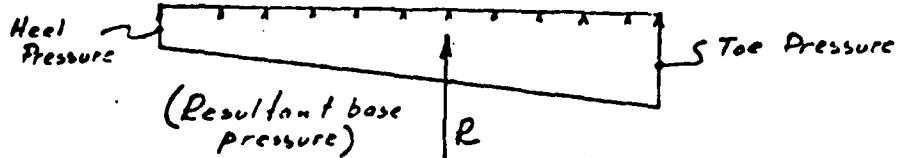
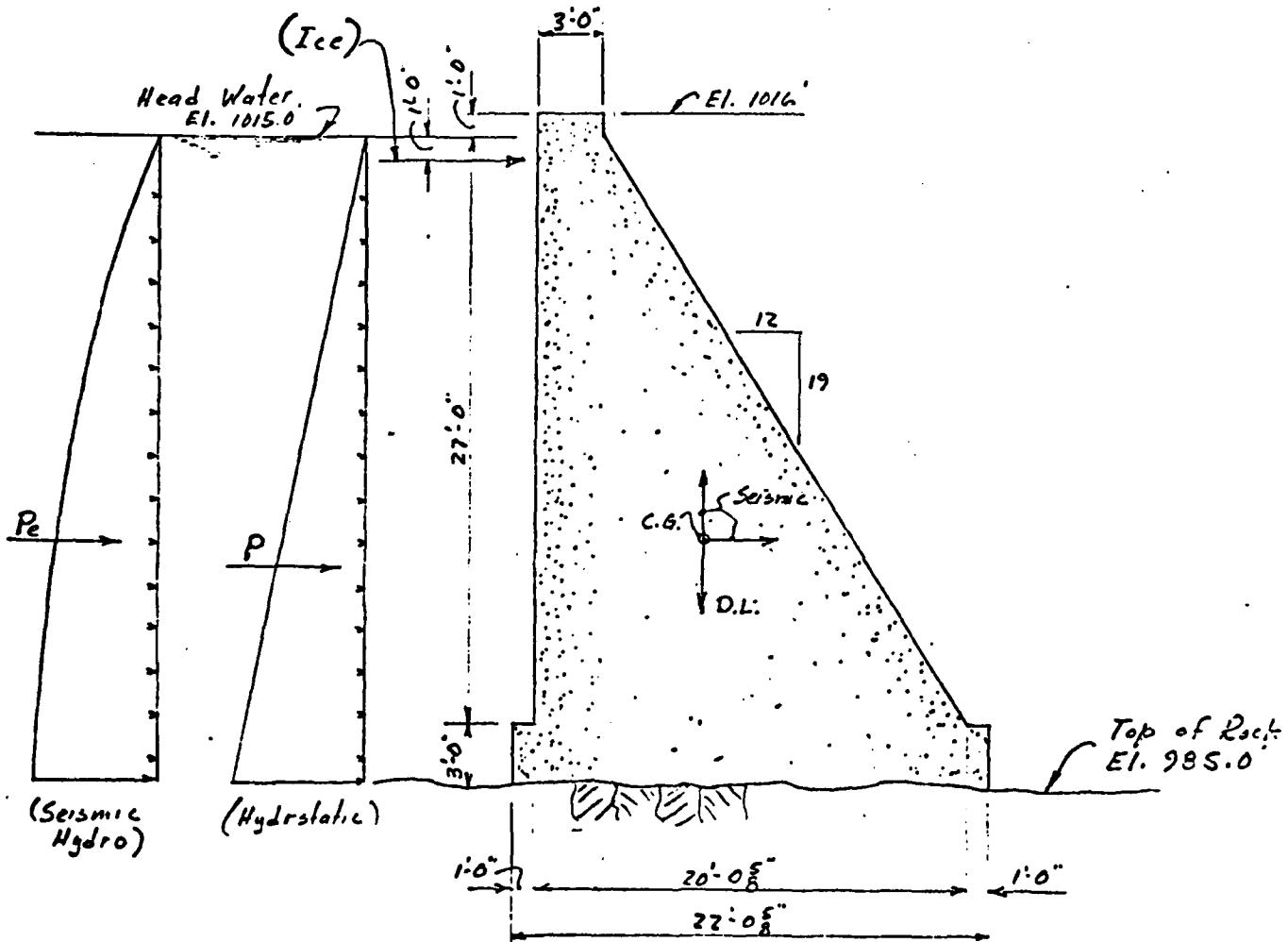
	Normal Operation	Extreme Operation
Heel or Toe Stress (Compression)	$\leq 500 \text{ P.S.I.}$	$\leq 750 \text{ P.S.I.}$
Heel or Toe Stress (Tension)	None	$\leq 20 \text{ P.S.I.}$
Sliding Coefficient (f)	$\leq .70$	$\leq .75$
Overturning $\left(\frac{M_e}{M_o}\right)$	≥ 1.50	≥ 1.25

APR 7 1973

ENGINEERING
P. I. P. C.

Client: Palisades Interstate Park Commission Job No. 3308-1 Sheet 2 of 16
 Subject: Lake Welch Dam Project By H. J. Klemmer Date 3/13/78
Dam Stability Analysis Rev.

Forces acting on dam & Concrete Outline



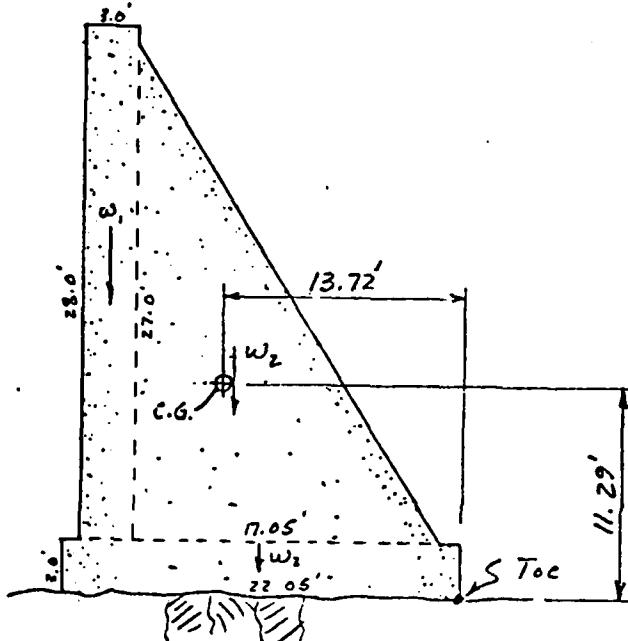
TYPICAL DAM CROSS SECTION

DATA

Client Dakota Interstate Park Commission Job No. 3308-1 Sheet 3 of 16
 Subject Lake Welch Dam Repairs By R.P.P.C. Date 3/13/78
Dam Stability Analysis Ckd. _____ Rev. _____

Dead Loads

Concrete weight = 145#/ft^3



$\Sigma M @ \text{Toe}$

$$w_1 = .145 \times 3.0 \times 28.0 = 12.18^k \times 19.55 = 238.1^k$$

$$w_2 = \frac{1}{2} \times .145 \times 17.05 \times 27.0 = 33.38 \times 12.37 = 412.9$$

$$w_3 = .145 \times 22.05 \times 3.0 = \frac{9.57}{55.15} \times 11.025 = 105.7$$

$$F_v = \frac{55.15^k}{55.15^k} \quad M_R = 756.7$$

$$e_h = \frac{756.7}{55.15} = 13.72'$$

$$\begin{aligned} 12.18 &\times 17.0 &= 207.1 \\ 33.38 &\times 12.0 &= 400.6 \\ \frac{9.57}{55.15} &\times 1.5 &= \frac{14.3}{622.4} \end{aligned}$$

$$e_v = \frac{622.4}{55.15} = 11.29'$$

Summary

$$F_v = 55.15^k$$

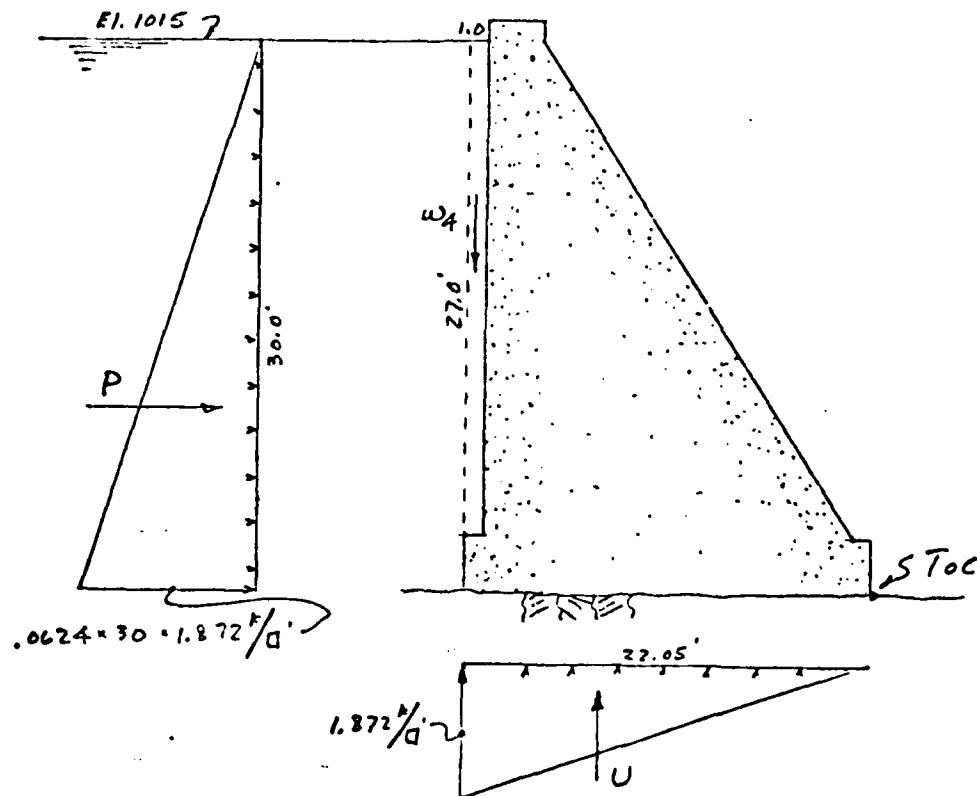
$$M_R = 756.7^k$$

P.T.O.

Client Palisades Interstate Park Commission Job No. 3308-1 Sheet 4 of 16
 Subject Lake Watch Dam Repair By P. P. Powers Date 3/13/78
Dam Stability Analysis Ckd. Rev.

Hydrostatic Forces

Weight of Water = 62.4 lb/ft^3



EM @ Toe

$$\begin{aligned}
 P &= \frac{1}{2} \times 1.872 \times 30.0 = 28.08 \text{ k} \\
 U &= \frac{1}{2} \times 1.872 \times 22.05 = -20.64 \text{ k} \\
 W_1 &= 0.624 \times 1.0 \times 27.0 = 16.8 \text{ k} \\
 U &= -18.96 \text{ k}
 \end{aligned}$$

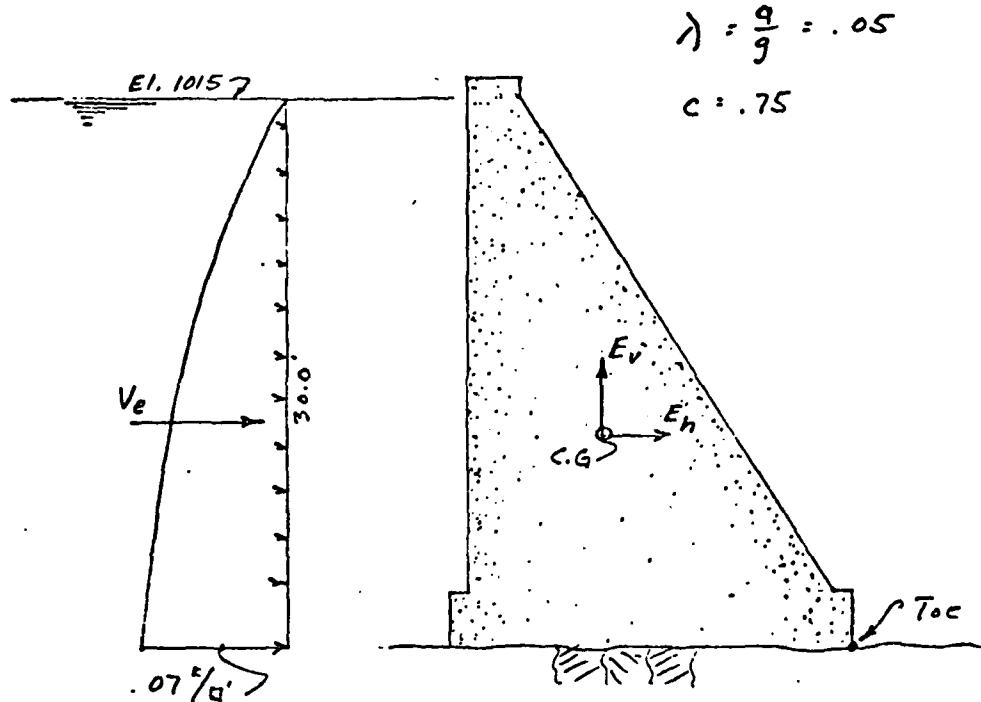
$$M_R = \frac{16.8 \times 21.55}{584.2} = 36.3 \text{ in}$$

Summary

$$\begin{aligned}
 F_V &= -18.96 \text{ k} \\
 F_H &= 28.08 \text{ k} \\
 M_R &= 36.3 \text{ in} \\
 M_o &= 584.2 \text{ in}
 \end{aligned}$$

Client Palisades Interstate Park Commission Job No. 33-C8-1 Sheet 5 of 16
 Subject Lake Welch Dam Project By H.M. Palmer Date 3/13/78
Dam Stability Analysis Chk. Rev.

Seismic Forces



$$P_e = .15 + .05 \times .0624 \times 30.0 = .07 \text{ kips}$$

EM@Toe

$$\begin{aligned}
 V_e &= .726 \times .07 \times 30.0 = 1.53 \text{ k} \\
 E_h &= .05 \times 55.15 = \frac{2.7L}{4.29} \times 11.29 = 31.2 \text{ k}
 \end{aligned}$$

$$\begin{aligned}
 E_v &= .05 \times 55.15 = F_v = 2.7L \text{ k} \approx 13.72 \text{ k} \\
 M_o &= \frac{37.9}{87.9 \text{ k}}
 \end{aligned}$$

Summary

$$F_v = -2.7L \text{ k}$$

$$F_h = 4.29 \text{ k}$$

$$M_o = 87.9 \text{ k}$$

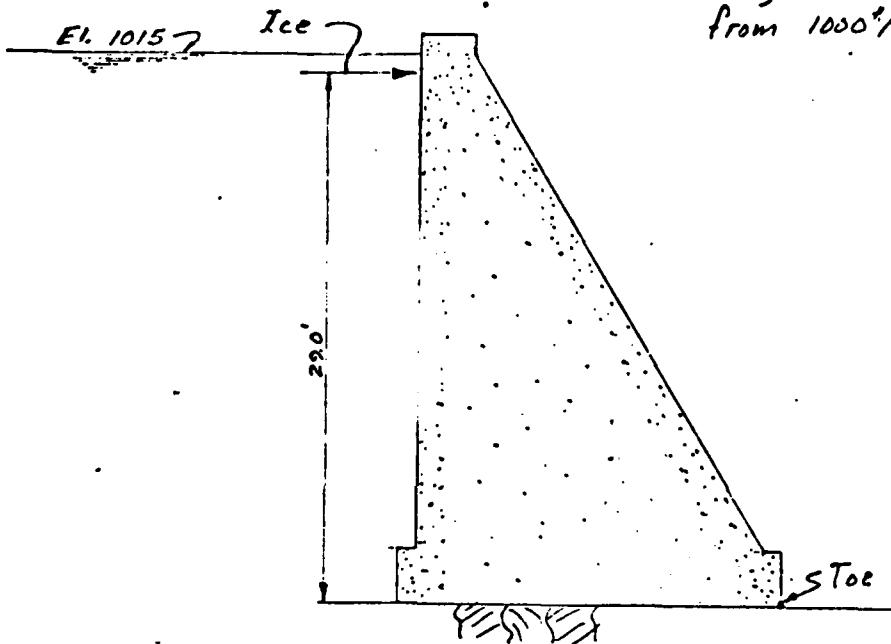
MAIN

Client: Palisades Interstate Park Commission Job No. 3308-1 Sheet 6 of 16
 Subject: Lake Welch Dam Repairs By EPC No. 1 Date 3/13/78
 Dam Stability Analysis Ckd. Rev.

Ice Forces

Ice Pressures

Vary in 1000# increments
 from 1000#/f.s. to 10,000#/f.s.



$\Sigma M @ \text{Toe}$

Summary

	F_H	M_o
(a)	$1^* \times 29.0$	$= 29''^n$
(b)	2×29.0	$= 58''^n$
(c)	3×29.0	$= 87''^n$
(d)	4×29.0	$= 116''^n$
(e)	5×29.0	$= 145''^n$
(f)	6×29.0	$= 174''^n$
(g)	7×29.0	$= 203''^n$
(h)	8×29.0	$= 232''^n$
(i)	9×29.0	$= 261''^n$
(j)	10×29.0	$= 290''^n$

Client Palo Alto Interlake Park Commission Job No. 3308-1 Sheet 7 of 16
 Subject Lake Welch Dam Project By H.O. Palomar Date 3/14/73
Dam Stability Analysis Ckd. _____ Rev. _____

Case I D.L. & Hydrostatic Forces Combined
 Normal

	F_v	F_H	M_R	M_o
D.L.	55.15	0.0	756.7	0.0
Hydrostatic	-18.96	28.08	36.3	584.2
	36.19	28.08	793.0	584.2

$$\Sigma M = 793.0 - 584.2 = 208.8 \text{ 'K} @ \text{Toe}$$

$$x = \frac{22.05}{2} - \frac{208.8}{36.19} = 5.26' \text{ downstream from base of dam}$$

$$\text{Resultant Location} = \frac{208.8}{36.19} - \frac{22.05}{3} = -1.58' \text{ outside kern}$$

OK

$$p = \frac{36.19}{22.05} \left(1 \pm \frac{6 \times 5.26}{22.05} \right) \frac{1000}{144} = 11 \pm 16 = \begin{cases} 27 \text{ PSI} @ \text{Toe} \\ -5 \text{ PSI} @ \text{Heel} \end{cases}$$

N.G.

$$\text{Sliding} = \frac{28.08}{36.19} = .78 > .70 \quad \text{N.G.}$$

$$\frac{M_R}{M_o} = \frac{793.0}{584.2} = 1.36 < 1.50 \quad \text{N.G.}$$

$\frac{t}{d}$

MAIN

Client Palisades Interstate Park Commission Job No. 37.08-1 Sheet 8 of 16
 Subject Lake Wallkill Dam Repair By DPA Palmer Date 3/14/78
Dam Stability Analysis Ckd. Rev.

Case II D.L., Hydrostatic & Seismic Forces Combined
Extreme

	F_v	F_H	M_R	M_o
D.L.	55.15"	0.0"	756.7"	0.0"
Hydrostatic	-18.96	28.08	36.3	584.2
Seismic	-2.76	4.29	0.0	87.9
	<u>33.43</u>	<u>32.37"</u>	<u>793.0"</u>	<u>672.1"</u>

$$\Sigma M = 793.0 - 672.1 = 120.9" \text{ @ Toe}$$

$$e = \frac{22.05}{2} - \frac{120.9}{33.43} = 7.41' \text{ downstream from base of } \text{dam}$$

$$\text{Resultant Location} = \frac{120.9}{33.43} - \frac{22.05}{3} = -3.73' \text{ outside kern}$$

OK

$$p = \frac{33.43}{22.05} \left(1 \pm \frac{6 \times 7.41}{22.05} \right) \frac{1000}{144} = 11 \pm 21 = \begin{cases} 32 \text{ PSI @ Toe} \\ -10 \text{ PSI @ Heel (Tensile)} \end{cases}$$

$$\text{Sliding } \frac{32.37}{33.43} = .97 > .75 \text{ N.G.}$$

$$\frac{M_R}{M_o} = \frac{793.0}{672.1} = 1.18 < 1.25 \text{ N.G.}$$

MAIN

Client Palisades Interstate Park Commission Job No. 2308-1 Sheet 9 of 16
 Subject Lake Welch Dam Repairs By R.C. La. Cane Date 3/12/78
Dam Stability Analysis Ckd. _____ Rev. _____

Case II(a) D.L., Hydrostatic & Ice (1000#/l.f.) Combined
 Extreme

	F_v	F_H	M_R	M_o
D.L.	55.15 ^{lk}	0.0	756.7	0.0
Hydrostatic	-18.96	28.08	36.3	584.2
Ice (1000#/l.f.)	0.0	1.0	0.0	29.0
	36.19	29.08	793.0	613.2

$$\Sigma M = 793.0 - 613.2 = 179.8 \text{ " @ Toe}$$

$$e = \frac{22.05}{2} - \frac{179.8}{36.19} = 6.06' \text{ downstream from base &}$$

$$\text{Resultant location} = \frac{179.8}{36.19} - \frac{22.05}{3} = -2.38' \text{ outside kern}$$

OK

$$p = \frac{36.19}{22.05} \left(1 \pm \frac{6 \times 6.06}{22.05} \right) \frac{1000}{144} = 11 \pm 19 = \begin{cases} 30 \text{ PSI @ Toe} \\ -8 \text{ PSI @ Heel} \end{cases}$$

OK

$$\text{Sliding} = \frac{29.08}{36.19} = .80 > .75 \text{ N.G.}$$

$$\frac{M_R}{M_o} = \frac{793.0}{613.2} = 1.29 > 1.25 \text{ OK}$$

t
d

(L) (R) (M)

Client: Palwaukee Interstate Park Commission Job No. 3308-1 Sheet 10 of 16
 Subject: Lake Welch Dam Repair By: P.M. LaCasse Date 3/14/78
Dam Stability Analysis Chkd. Rev.

Case III(b) D.L., Hydrostatic & Ice (2000#/l.f.) Combined
 Extreme

	F_v	F_H	M_R	M_o
D.L.	55.15 ^K	0.0 ^K	756.7 ^{IK}	0.0 ^{IK}
Hydrostatic	-18.96	28.08	36.3	584.2
Ice (2000#/l.f.)	0.0	2.0	0.0	58.0
	36.19 ^K	30.08 ^K	793.0 ^{IK}	642.2 ^{IK}

$$EM = 793.0 - 642.2 = 150.8^{\prime\prime} \text{ @ Toe}$$

$$e = \frac{22.05}{2} = \frac{150.8}{36.19} = 6.86' \text{ downstream from base of dam.}$$

$$\text{Resultant location} = \frac{150.8}{36.19} - \frac{22.05}{3} = -3.18' \text{ outside kern}$$

$$p = \frac{36.19}{22.05} \left(1 \pm \frac{6 \times 6.86}{22.05} \right) \frac{1000}{144} = 11 \pm 21 = \begin{cases} 32 \text{ P.S.I. @ Toe} \\ -10 \text{ P.S.I. @ Heel} \end{cases}$$

OK

$$\text{Sliding} = \frac{30.08}{36.19} = .83 > .75 \text{ N.G.}$$

$$\frac{M_R}{M_o} = \frac{793.0}{642.2} = 1.23 < 1.25 \text{ N.G.}$$

t
d

P

Client Palisades Interstate Park Commission Job No. 3308-1 sheet 11 of 16
 Subject Lake Watch Dam Project By P.D. L. Date 3/19/78
 Dam Stability Analysis Chk. Rev.

Case III(c) D.L., Hydrostatic & Ice (3000#/f.s.) Combined Extreme

	F_v	F_H	M_R	M_o
D.L.	55.15 ^k	0.0 ^k	756.7 ⁱⁿ	0.0 ⁱⁿ
Hydrostatic	-18.96	28.08	36.3	584.2
Ice (3000#/f.s.)	0.0	3.0	0.0	87.0
	36.19 ^k	31.08 ^k	793.0 ⁱⁿ	671.2 ⁱⁿ

$$\Sigma M = 793.0 - 671.2 = 121.8 \text{ " @ Toe}$$

$$e = \frac{22.05}{2} - \frac{121.8}{36.19} = 7.66' \text{ downstream from base of}$$

$$\text{Resultant location} = \frac{121.8}{36.19} - \frac{22.05}{3} = -3.98' \text{ outside kern.}$$

OK

$$P = \frac{36.19}{22.05} \left(1 \pm \frac{6 \times 7.66}{22.05} \right) \frac{1000}{144} = 11 \pm 24 = \begin{cases} 35 \text{ PSI @ Toe} \\ -13 \text{ PSI @ Heel} \end{cases}$$

OK

$$\text{Sliding} = \frac{31.08}{36.19} = .86 > .75 \quad \text{N.G.}$$

$$\frac{M_R}{M_o} = \frac{793.0}{671.2} = 1.18 < 1.25 \quad \text{N.G.}$$

MAIN

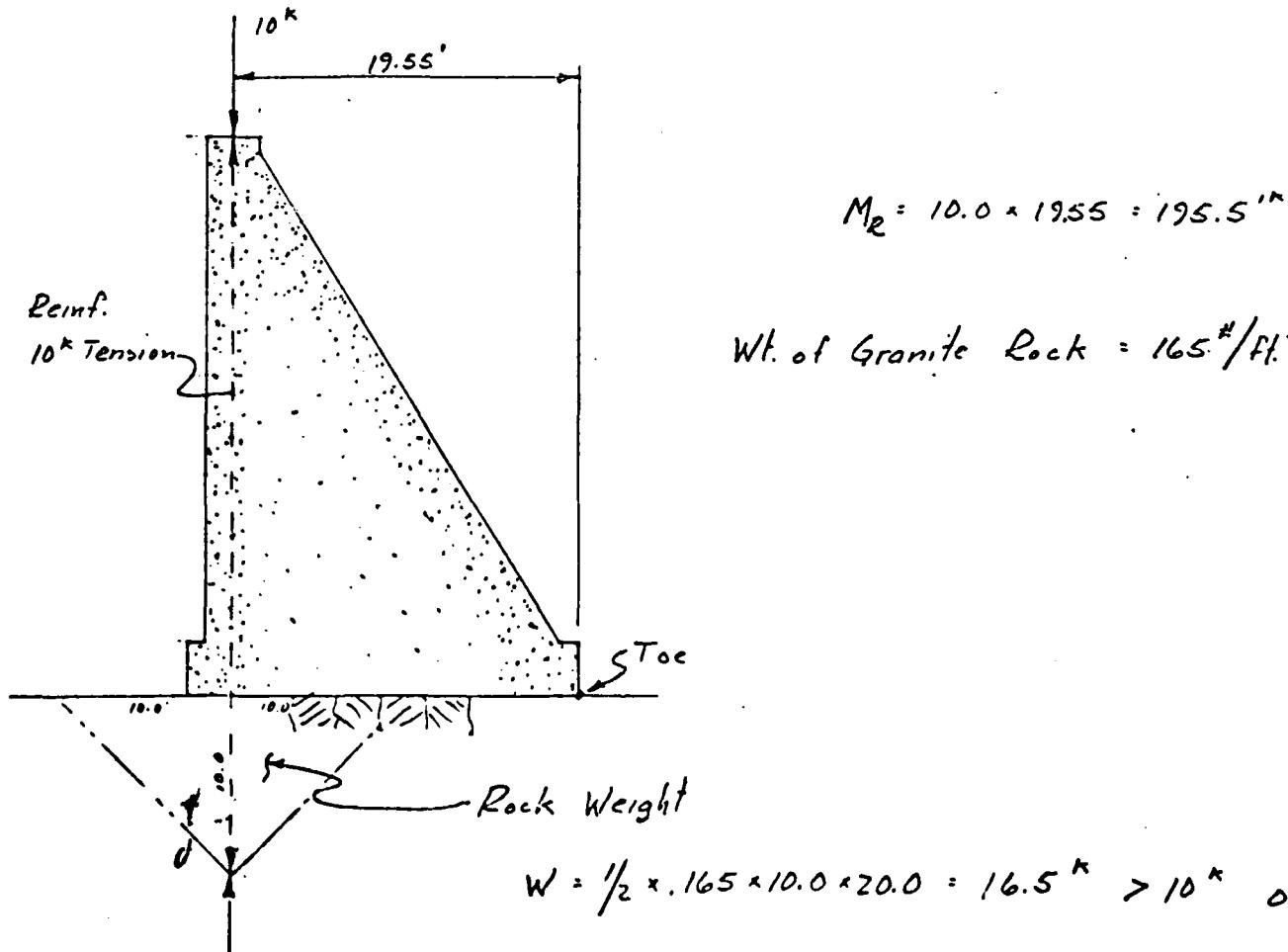
Client: Palisades Interstate Park Commission Job No. 3308-1 Sheet 12 of 16
 Subject: Lake Welch Dam Repairs By P.P. Palmer Date 3/31/78
Dam Stability Analysis Chkd. Rev.

Reinforcement - Williams Rock Bolt US-11-HC-SCS-200
 Max. Working Load: 74,000[#]

$$\text{Design Load} = \frac{2}{3} \times 74,000 = 49,333^{\#} \pm \\ \text{Use } 50,000^{\#}$$

Bolt spacing @ 5' o.c.

$$\text{Load per ft} = \frac{50,000}{5} = 10,000^{\#}/\text{l.f.}$$



Summary

$$F_v = 10^k$$

$$M_R = 195.5''$$

(NAPKIN)

Client Palo Verde Interstate Park Commission Job No. 3308-1 Sheet 13 of 16
 Subject Lake Meekle Dam Concrete By J.D. Palmer Date 3/31/78
Dam Stability Analysis Chkd. _____ Rev. _____

Case IV D.L., Hydrostatic & Reinforcement Combined
 Normal (Case I & Reinf.)

	F_v	F_u	M_2	M_o
Case I	36.19"	28.08"	793.0"	584.2"
Reinf.	10.00	0.0	195.5	0.0
	46.19"	28.08"	988.5	584.2

$$\Sigma M = 988.5 - 584.2 = 404.3 \text{ @ Toe}$$

$$e = \frac{22.05}{2} - \frac{404.3}{46.19} = 2.27' \text{ downstream from base of}$$

$$\text{Resultant location} = \frac{404.3}{46.19} - \frac{22.05}{3} = 1.40' \text{ inside kern OK}$$

$$p = \frac{46.19}{22.05} \left(1 \pm \frac{6 \times 2.27}{22.05} \right) \frac{1000}{144} = 15 \pm 9 = \begin{cases} 24 \text{ PSI @ Toe} \\ 6 \text{ PSI @ Heel} \end{cases} \text{ OK}$$

$$\text{Sliding (f)} = \frac{28.08}{46.19} = .61 < .70 \text{ OK}$$

$$\text{Overturning } \left(\frac{M_R}{M_o}\right) = \frac{988.5}{584.2} = 1.69 > 1.5 \text{ OK}$$

t
d

MAIN

Client Palisades Interstate Park Commission Job No. 3308-1 sheet 14 of 16
 Subject Lake Welsh Dam Paper By J.C. Palmer Date 3/31/78
Dam Stability Analysis Ckd. Rev.

Case II D.L., Hydro, Seismic & Reinforcement Combined
Extreme (Case II + Rem f)

	F_v	F_h	M_R	M_o
<u>Case II</u>	<u>33.43^k</u>	<u>32.37^k</u>	<u>793.0^{lk}</u>	<u>672.1^{lk}</u>
	<u>10.00</u>	<u>0.0</u>	<u>195.5</u>	<u>0.0</u>
	<u>43.43</u>	<u>32.37</u>	<u>988.5</u>	<u>672.1</u>

$$\Sigma M = 988.5 - 672.1 = 316.4^{lk} @ \text{Toe}$$

$$z = \frac{22.05}{2} = \frac{316.4}{43.43} : 3.74' \text{ downstream from base \&}$$

$$\text{Resultant location} = \frac{316.4}{43.43} - \frac{22.05}{3} = -.06' \text{ outside kern}$$

$$P = \frac{43.43}{22.05} \left(1 \pm \frac{6 \times 3.74}{22.05} \right) \frac{1000}{144} = 14 \pm 14 = \begin{cases} 28 \text{ PSI @ Toe} \\ -0 \text{ PSI @ Heel} \end{cases}$$

$$\text{Sliding (f)} = \frac{32.37}{43.43} = .75 \quad \text{OK}$$

$$\text{Overturning } \left(\frac{M_e}{M_o} \right) = \frac{988.5}{672.1} = 1.47 > 1.25 \quad \text{OK.}$$

t.
d

(MAIN)

Client Palisades Interstate Park Commission Job No. 3308-1 Sheet 15 of 16
 Subject Lake Welsh Dam Repairs By R.D. Palmer Date 3/31/78
Dam Stability Analysis Chd. _____ Rev. _____

Case IV(c) D.L., Hydro, Ice (3000#/l.f) & Reinf. Combined
 Extreme (Case III(c) & Reinf.)

	F_v	F_h	M_r	M_o
Case III(c)	36.19	31.08	793.0	671.2
Reinf	<u>10.00</u>	<u>0.0</u>	<u>195.5</u>	<u>0.0</u>
	46.19	31.08	988.5	671.2

$$\Sigma M = 988.5 - 671.2 = 317.3' k @ \text{Toe}$$

$$d = \frac{22.05}{2} - \frac{317.3}{46.19} = 4.16'$$

$$\text{Resultant location} = \frac{317.3}{46.19} - \frac{22.05}{3} = -.48' \text{ outside kern}$$

$$p = \frac{46.19}{22.05} \left(1 \pm \frac{6 \times 4.16}{22.05} \right) \frac{1000}{144} = 15 \pm 16 = \begin{cases} 31 \text{ PSI} @ \text{Toe OK} \\ -1 \text{ PSI} @ \text{Heel OK} \end{cases}$$

$$\text{Sliding (f)} = \frac{31.08}{46.19} = .67 < .75 \text{ OK}$$

$$\text{Overturning} \left(\frac{M_r}{M_o} \right) \cdot \frac{988.5}{671.2} = 1.47 > 1.25 \text{ OK}$$

$\frac{t}{d}$

MAIN

Client: Palisades Interstate Park Commission Job No. 3308-1 Sheet 16 of 16
 Subject: Lake Welch Dam Pressure By P.D.L. Date 3/15/78
 Dam Stability Analysis Ckd. Rev.

Dead Load	Hydrostatic	Earthquake	Ice	Toe Pressure (lb/in.)	Heel Pressure (PSI)	F_H/F_v	Overturning Moment to D.S. Kern	Resultant Location to D.S. Kern
se I (normal)	✓	✓	✓	27	- 5 ④	.78 ③	1.36 ②	- 1.58'
se II (tremor)	✓	✓	✓	32	- 10	.97 ④	1.18 ③	- 3.73'
se III (a) (tremor)	✓	✓	✓	1000	- 8	.80 ③	1.29	- 2.38'
se III (b) (tremor)	✓	✓	✓	2000	- 10	.83 ③	1.23 ③	- 3.18'
se III (c) (tremor)	✓	✓	✓	3000	- 13	.86 ③	1.18 ③	- 3.98'
se IV (normal)	✓	✓	✓	24	6	1.61	1.69	1.40'
se V (tremor)	✓	✓	✓	28	- 0	.75	1.47	-.06'
se VI (c) (tremor)	✓	✓	✓	3000	31	- 1	.67	1.47
								- .48'

① Minus (-) Sign indicates tension.

- ② Minus (-) Sign indicates resultant outside kern.
 & tension at heel.
- ③ Does not meet criteria

MANUAL COMPUTATION

**Palisades Interstate
Park Commission
Administration Building
Bear Mountain, NY 10911
914 786-2701**

Nash Castro
General Manager



April 25, 1980

**Mr. J. Patel
Tippetts-Abbett-McCarthy-Stratton
Engineers and Architects
The Tams Building
655 Third Avenue
New York, New York 10017**

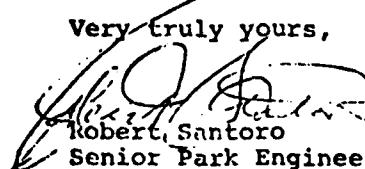
Dear Mr. Patel:

As requested, enclosed are the following documents:

1. Sheet 1 of consultant design agreement showing scope of services.
2. Correspondence from Chas. T. Main, Inc. dated October 5, 1977, March 31, 1978 and April 7, 1978.
3. Copies of diary sheets from October 9, 1978 to November 12, 1978.

Please call if you need any additional information.

Very truly yours,


Robert Santoro

Senior Park Engineer

RS:mgs
Encs:

RECEIVED
APR 26 1980
SOILS SECTION

REGION - Palisades

PROJECT NAME - Repairs to the Lake Welch Dam

P. F. NO. -

THIS AGREEMENT made this _____ day of _____ 19_____, by and between the State of New York, acting by and through the Office of Parks and Recreation, hereinafter referred to as "PARKS", whose office is at Administration Building,
Bear Mountain, New York 10511

and - Chas. T. Main of N.Y. Inc., with offices at 125 E. 38th Street, New York,
New York 10016

hereinafter referred to as the "CONSULTANT."

WITNESSETH:

WHEREAS, PARKS is charged by the law with the construction, maintenance and operation of state parks, parkways, historic sites, marine facilities and other recreational facilities and desires to obtain technical and professional services therein as hereinafter specified, and is authorized to engage such services in accordance with the provisions of the Parks and Recreation Law of the State of New York.

NOW, THEREFORE, in consideration of the premises and the mutual covenants and conditions contained herein the parties hereto agree as follows:

I. SCOPE OF SERVICES — PARKS agrees to employ and hereby does employ the CONSULTANT for the services hereinafter described, and the CONSULTANT agrees to furnish and perform such services upon the following described project:

Repairs to the Lake Welch Dam

The consultant will furnish services related to the repair of the Lake Welch Dam by means of chemical and cement grouting of horizontal construction joints and sealing of vertical expansion joints.

The method to be recommended by the consultant will enable the repair work to be carried out without the necessity of emptying the lake.

More specifically, the scope of the consultants' services shall consist of four parts, itemized as follows:

Item 1 - Inspection of the dam, attendance at meetings, and other work required to propose a solution to the leakage problems, all performed prior to January 1, 1978.

Item 2 - Performance and documentation of a stability analysis of the dam so as to determine the basic soundness and integrity of the dam.

Item 3 - Under the assumption that the results of the analysis described in Item 2 show the dam to be essentially sound and capable of repair, the consultant will prepare drawings and specifications for the drilling, grouting and sealing of the dam. If the results of the work performed under Item 2 indicate that the dam is not sound or that some other means of repair are indicative, this agreement may be terminated or amended as appropriate to the conditions at this point.

Item 4 - Field surveillance of the drilling, grouting and sealing work after the award of the construction contract by Parks.

The Consultant will furnish contract drawings in reproducible form after approval of preliminary drawings by Parks.

The Consultant will also furnish five (5) copies each of detailed contract

MAIN
Engineers

CHAS. T. MAIN OF NEW YORK, INC.
UHL, HALL & RICH DIVISION
125 EAST 38TH STREET, NEW YORK, NEW YORK 10016

5 October 1977

9010205-150

Mr. Robert Santoro
Palisades Interstate Park Commission
Administration Building
Bear Mountain, NY 10911

OCT 7 1977
ENGINEERING
P. I. P. C.

Dear Sir:

In compliance with your request we have undertaken a study of the leakage problem at Lake Welch Dam. The site was visited and we inspected the concrete cores obtained from the dam. We understand the need to reduce leakage through the dam and its foundation to a minimum and we appreciate the desirability of avoiding draining the lake. Considering both of these requirements, we offer the following solution:

1. Sealing of the horizontal construction joints of the dam, and the foundation of the dam and its abutments, by a combination of cement and chemical grouting.
2. Sealing of the vertical contraction joints by drilling a large (6") hole vertically through each joint and backfilling with a non-setting sealant.
3. The above procedures are to be performed in the early Spring of 1978 without the lake being drained.
4. Observation of the dam, foundation and sluice gate leakage through September 1978 when decisions can be made relative to:
 - a. Draining the lake to effect additional grouting or repairs, if indicated, to the upstream face of the dam.
 - b. The need for a new sluice gate, or the repair of the existing gate.
 - c. Refacing or repairing the downstream face of the dam for aesthetic reasons.
 - d. Performing other remedial work, also for aesthetic reasons.

It is our opinion that steps 1 and 2 above will successfully reduce leakage to a practicable minimum at the least cost. This solution has the further advantage of not requiring the draining of the lake during the recreation season. Should additional work

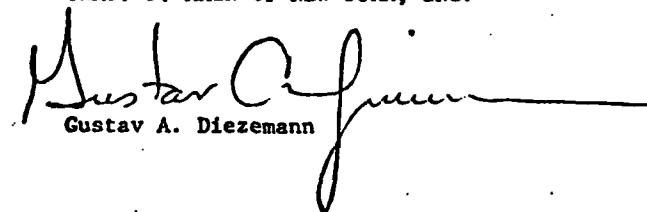
R. Santoro
5 October 1977
Page 2

requiring the draining of the lake be necessary, such can be performed early next Fall and the lake refilled before the 1979 season. We estimate the cost of steps 1 and 2 to be not in excess of \$225,000.

It is proposed that MAIN write the specification for the grouting program and provide a resident engineer for the surveillance of the field work. We estimate that the total cost of our services will not exceed \$30,000 up to and including steps 1 and 2. This figure is based on an estimate of 55 working days to perform steps 1 and 2.

We will be happy to discuss this subject with you and are available to meet with you at your convenience.

Yours very truly,
CHAS. T. MAIN OF NEW YORK, INC.


Gustav A. Diezemann

GAD:dc

cc: Mr. Thomas F. Connors
New York State Park & Recreation

FRIDAY, OCTOBER 14, 1977

Name	Representing
Ivan Vamos	OPR Central Office / Dept. Commis.
Dr. Peter J. R. Buttner	" " " / Dir Env. Mgt.
W. Roland Soucy	OAS-DPC / Envir.
JOHN J TROY	PIPC
Bob Santoro	PIPC
Gus Diezemann	Clas. T. Main
CHARLES P. BENZIGER	" " "
FRANCIS W. HOSKINS	OAS-DPC
John J. S. Knorr	OCC D+C
James E. Cassidy	OGS-DPC
THOMAS F. CONNELL	CPR - Recorment
THOMAS STROZINSKI	CPR - Recorment
NATHAN CASTRO	PALISADES INSTANTIC PART COMM.
Mark Hawken	CPR

MAIN
Engineers

CHAS. T. MAIN OF NEW YORK, INC.

125 EAST 38TH STREET, NEW YORK, NEW YORK 10016

GT & RS
APR

March 31, 1978

3308-001-1

Mr. Robert Santoro
Palisades Interstate Park Commission
Administration Building
Bear Mountain, New York 10911

RECEIVED
APR 7 1978

Dear Mr. Santoro:

ENGINEERING

Further to the draft of the report on our stability analysis of the Lake Welch Dam, we wish to advise you that post-tensioned rock bolts, five feet on centers and ten feet into rock, placed in reamed grout holes through the top of the dam would produce the following ratios of forces:

	Sliding	Overshooting
Case I	1.64	1.69
Case II	1.33	1.47
Case III	1.49	1.47

The addition of the rock bolts improve the resistance to sliding and overturning significantly, as the above figures indicate. While there is nothing to assure that the dam would fail without the rock bolts, there is similarly no guarantee that the dam will never fail with the rock bolts installed. Considering the age and condition of the Lake Welch Dam, it is obviously prudent to install the bolts during the rehabilitation procedure. We estimate the cost of installation to be \$93,000.

Very truly yours,

CHAS. T. MAIN OF NEW YORK, INC.

Gustav A. Diczemann

CAD:vc

MAIN
Engineers

CHAS. T. MAIN OF NEW YORK, INC.
125 EAST 38TH STREET, NEW YORK, NEW YORK 10016

L.P.
9T

April 7, 1978

3308-001-1

Mr. Robert Santoro
Palisades Interstate Park Commission
Administration Building
Bear Mountain, New York 10911

MR 10 1978

Dear Mr. Santoro:

ENGINEERING

P. I. P. C.

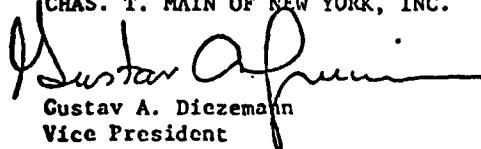
Reference is made to our letter of October 5, 1977 in which we stated that, if the recommended sealing of the horizontal and vertical joints and the foundation of the Lake Welch Dam did not satisfactorily stop the leakage, the lake could be drained to effect additional grouting or repairs.

We also stated in that letter that we believed that the recommended sealing would reduce the leakage to a practicable minimum. We are still of that opinion. We cannot, however, for obvious reasons, guarantee that it will.

Should additional repairs be necessary, and we repeat that we believe the recommended will be successful, it is not possible to estimate the cost of such repairs until the problem, if any, is known.

Very truly yours,

CHAS. T. MAIN OF NEW YORK, INC.


Gustav A. Diczemann
Vice President

CAD:vc

~~Wednesday~~

- Chipping stones in
in planning a new embankment
Dug out $1\frac{1}{2}$ ft. 23 ft. l.

Started Grouting - about 9:10 A.M.
Then 7 - 8 galls water / Cement
2 Sand, 1/2 Cement - horses
Cut sand down to 1 shovel
per mix, Grated ~~the~~
Section 1, 2, 3, 2 Holes
on Sectional & Grout network
Carried out of left seam
Took pressure up to 65 lbs
Horses hold one pressure
Charted section & 2 stories 13 ft
23 ft

64 C.F.T.

All holes at 1/2 inch from
bottom except
1/4 in.

284

OCTOBER 10

Clarie WrennStarted Chipping 12:00.

Gouttine Hole 9 1/3 Great Cane
Up 4 1/4. Lowered Deck & 1/2 1/3
At 12 PT Taken Put Duster
12 1/4 PT. Gouttine 50 lbs Tan
1.5 min. then 35 1/2 for 15 min.
re. ground come out of left front
wake. Slanted down in hole
about 1 1/2 ft
Ground 5 1/4 25 ft the 45 ft no
no pockets, back make one
Shovel Chipping & more

Last batch in hole or 5 1/2
hole. paper off when dryings
to back out. will have to
fill hole along back of et.

all holes are filled from bottom
up
Bolts in 3 stones 13 ft 3 ft

GL

All holes are filled from bottom
up
each from 5 ft to 12 ft down
in minutes. Club Simpson

285

OCTOBER 11

Clarie Wrenn

Shovel Chipping 8:00 A.m.
checked & take all of quarry
Shotcrusher and make each section
One Shovel don't like it. put 1/2
1.5 min. then 35 1/2 for 15 min.
shovelteer dryings in cracks
re. ground come out if any appear

Shovel Chipping 12-3:00
about 1 1/2 ft
Ground 5 1/4 25 ft the 45 ft no
no pockets, back make one
Shovel Chipping & more

reaming out ground holes
fill him to back holes out
office stone (about 6)

All holes are filled from bottom
up
each from 5 ft to 12 ft down

OCTOBER 12

C.C.C. (W.M.F.)

- Hopping shovels etc. to men
- Plated Graveling at 10
- Gravel pit selected 8, 9, 10,
- going away but called
- stone collected up, kiln fired
- running holes out told them
- he could wash out right
- after running (about 10) Sept 9 took Dono Bruce to
- quarry hauled down 4:20 N. T. Beginning in Transversal broken

OCTOBER 13

C.C.C. (W.M.F.)

No Graveling to 10 1/2
Cutting Specway 3 men
Air Tractor W.M.F. train and
Dashed the horse & started out
Section 1, 2, 3, 4, 5/1

Drilled 5 1/2 31 ft.
Brought Stone here on tops

Collected lime under Cuckoo Rock
all and 14" or 15" high broken
and they are coming

P.L.

J.H.

290

OCTOBER 16

Cement	Concrete	Brick	Wood
Quarried	11 1/2	11 1/2	11 1/3
	12 ft	12 1/2	12 1/3

Gravel 11 1/2 Cement 11 1/3)
Sand 2 bags Dressed 26 Cu. Ft. 1
Stones 10 Cu. Ft. 1 Cement 11 1/3
is early stone is then I
left for 5 min & start 20 ft
more later.

Patching 5 1/2 ft 1/3 the remaining
brick hole to 6 inches diameter
which will now no they are completed.

6 ft

asked him "What's all the big equipment
you want?" He said "I want my boat
from 210 brick on Harbor vessel
exception 1500 to 2000 ft of concrete
and sand for here".
"I'll help you get it".

"I'll help you get it".
"I'll help you get it".

OCTOBER 17

Cement	Concrete	Brick	Wood
Quarried	11 1/2	11 1/2	11 1/3
	12 ft	12 1/2	12 1/3

REMOVING OUR GROUTED HORSE HIZO
WASHING THEM OUT.

OCTOBER 18

292

OCTOBER 18

Spent ^{an hour}
Started - drilling sprue
So 3 men
Boring ground out of hole
Brought flat form back
to section 6

293

OCTOBER 19

Spent ^{an hour}
Started - drilling sprue
So 3 men
Boring ground out of hole
Brought flat form back
to section 6

Let them drill some at
the chemical front. It
was enough apart so that
there is no chance of
between holes to find him.
He could do it until he
would be responsible for
the holes he sand away.

7/1	Clin	23
6/1	"	23
6/3	"	23
6/6	"	23
6/8	"	23
5/6	"	22
5/3	"	22
5/1	"	22

29

OCTOBER 20

112

10

295

Gesetz über die
Gewerbeaufsicht

11

Wicket shipping generally
also has 2 bottom deckings, one
walked down grat holes
and another deck which
is built up on the outer
side of each walkway as follows.

3	/	4	16
3	/	4	16
3	/	1	16
3	/	1	16

Con G

98

My Journal

- 1 -

296

OCTOBER 24

Driving liaison
Bore holes 12" holes 4 done.
Large pieces of rock for concrete
Some bushes of very hard shrubbery planted on each side
area of 2 hr per hole section
approximately
Building float for drill,
Tool of 25 gal oil drums
don't think it will hold weight
of drill.

Gas

5 lbs

OCTOBER 23

297

Driving liaison
Bore 12" holes, hand truck
new section 2 min. etc
planted on each 3,

298

OCTOBER 23, 1933

L. H. M.

Burkhardt started to drill his
cannibalized float and put his
on at a 35° pitch not holes
being fit of cannibalized
blasting 12" holes over called.
Chuck Bergner, told him
1" holes are very hard brilliant
and I work at it when drill
a series of 20' 3/4 inch holes
around template to make it
easier on stand of bit and
subsequent work ok so far
1/4 hole one 6 1/2" in deep
Composite kickin' 31 yard section &
contractor came & shoot at
dinner for dry coat & sand
ักษะห์ - he said he needed
at least 5 or 7 days of 70 degree
at curve exposed
drilling right in
at first thought will not
cause any damage great.

299

OCTOBER 25, 1933

L. H. M.

Chipping	Splicing	Drilling
2 holes	2 holes	Build float back rest on to oil & tanks (soogal.)
		Diamond drilling holes composite
		sector # 0 5

holes are very hard brilliant
and I work at it when drill
a series of 20' 3/4 inch holes
around template to make it
easier on stand of bit and
subsequent work ok so far
1/4 hole one 6 1/2" in deep
Composite kickin' 31 yard section &
contractor came & shoot at
dinner for dry coat & sand
ักษะห์ - he said he needed
at least 5 or 7 days of 70 degree
at curve exposed
drilling right in
at first thought will not
cause any damage great.

३

OCTOBER 25

103

Oct 26th Rain ✓ : not regular.
in 26th
noted bottom of Rock bolt. Last look Tongue on Gage
as all Core b. 2 Standard 8 ft acid hydrochloric. Yellow precipitate
and on B. 8 ft, blue. Crystallized

Oct-26, it rains V is not regular

252 ft.
61 ft.

١٢

۲۷۰

$$\frac{2}{3} \cdot \frac{3}{2} = 1$$

35

OCTOBER 30

Libby Mild

15/3	$26+10 = 36$		
16/1	$25+10 = 35$		
16/2	$22+10 = 32$		
	30	29	
16/3	$20+10 = 30$		
17/1	$12+12 = 24$	$24+22 = 46$	
17/2			
19/2			

15/3	$26+10 = 36$		
16/1	$25+10 = 35$		
16/2	$22+10 = 32$		
	30	29	
16/3	$20+10 = 30$		
17/1	$12+12 = 24$	$24+22 = 46$	
17/2			
19/2			

Chipping Spurway. 44 Crews. Allowance Boat Charge. Insurance

Forward 16x100' Derr.

but 650 lbs on No. 3 hold bolt	1	1	26.1
in section 5: does not hold bolt	2	2	24.1
keep coming up, on No. 1 & 2	3	3	21.1
line	2	1	26.1
bolt	2	2	23.1
of No. 3 of hold drain hole	3	3	24.1
expanding drilled stone 12" hole	3	1	24.1
	2	2	25.1
lock bolt 1 30 ft Grated	1	1	24.
2 30 ft Not Grated	8	2	37.
3 30 ft Both Grated	3	3	32.
	4	4	30.
allowance Bolt Plain Cone, strong	1	1	30.
enough long right except gauge	2	2	32.
2nd set 6" flange 19 -	6	6	66.
1st set 6" flange 18 -	6	6	66.

Lubrication Bolt Plain Cone, strong
enough long right except gauge
(except first set)

306

NOVEMBER 1

Silica Mill^{"5000' Day"}

Shaded Chipping

Chipping Spallway. 2 Crews

Ground Section 13, 14, 15, 16,
17, 18, 19, 20
Chipped Rock Boulders
6 1/2 31 ft. Gravel River Bed

Leave Rose Anchors Boulders
Sect. 1, 2, 3, 4, 5 & 1 in C.
7 1/3 33 ✓ 2 1/2 4 1/4
1 1/3 33 ✓ 2 2 4 1/4
8 1/1 34 ✓ 2 1/3 5 1/2
5 1/3
6 1/1

28

307

NOVEMBER 2

Shaded Chipping

28 307

Eff 211 Grout Houses Drives

19 1	8	15	10	17 1/1	16
19 2	8	16	9	17 2	8
19 3	8	19	9	3	1
19 4	12	16	9	4	1
19 5	5	18	2	5	1
19 6	5	16	8	6	1
19 7	5	16	8	7	1
45	11/8	8	8	19	

Electric machine 1500 kva
so far the motor has run 100 hours.

308

NOVEMBER 3

~~Boar~~ Drilling. Sodding. 3 hours
drilling. 12' Holes completed.

7	2	33 ft.	torqued to 600 ft. lbs.
8	3	32 ft.	28
9	1	34 ft.	28 ft.
9	~	36 ft.	28 ft.
9	3	36 ft.	28 ft.

309

NOVEMBER 4

Boar Drilling. 3 hours
drilling. 12' Holes completed.
Dug bottom's

13	1	30 ft.	✓
13	2	30 ft.	✓
13	3	30 ft.	✓
14	1	30 ft.	(or 30 ft.) ✓
14	2	30 ft.	✓
14	3	30 ft.	✓
14	4	30 ft.	✓
15	1	30 ft.	✓
15	2	28 ft.	✓
15	3	28 ft.	✓

14	1	30 ft.	✓
14	2	30 ft.	✓
14	3	30 ft.	✓
14	4	30 ft.	✓
15	1	30 ft.	✓
15	2	28 ft.	✓
15	3	28 ft.	✓

1:00 Electric machine arrested.

310

NOVEMBER 5

311

NOVEMBER 6

Silca labam

Shipping 4 Crews

Cleaning 1/2 Holes and
Wooling Thread ready for
Plastic Grease

Granted up to 2 2/3

Dishilled Lock Bolts

10/1	34 ft
10/2	32 ft
10/3	31 ft

11/1	31 ft
11/2	32 ft
11/3	32 ft

Backfill cleaning ditch 8 h.
alongside dam,

Dressing Gravelled Holes
out ready for Rock Bolts

11 hrs	40 ft	40 ft	14 ft	14 ft
12	42			

312 NOVEMBER 7

Cheffing 2000ft 12' deep
2 men Cleaning.
1 Dynamite 2 men
1 man cleaning 12' hole
Blasting 12' holes

Dynamiting Chem grout holes
dynamited 10/1 11/1 12/1 Pulling
10/2 11/2 5
10/3 11/3 5
10/4 11/4 5
All 25 tons
1 Grouted 10/1 2, 3, 11/1, 2, 3,
9ccm 100ccm 12/1
Dynamited 10/1 2, 3, 11/1, 2, 3,
9ccm 100ccm 12/1
7/2 24
7/3 24
7/4 24
7/5 24
7/6 24
7/7 24
7/8 24

Blasted Chem holes

8/8	26 ft	13/1	42 ft	13.6 cu ft	36.73
15/2	26 ft	13/1	"	"	"
8/6	26 ft	13/2	"	"	"
15/5	26 ft	14/1	"	"	"
8/4	26 ft	14/2	"	"	"
8/8	3	26 ft	26 ft	26 ft	6 ft
8/8	2	26 ft	26 ft	26 ft	2 ft

NOVEMBER 3

Three shielded

Cleaning up site.

Boring holes

10/1	26.1
10/3	34.1
10/6	24.1
10/8	24.8
11/1	24.1
11/4	24.1
11/6	24.1
11/9	24.1

9/8	9.8
9/7	28.1
9/5	20.1
9/4	2.8
9/2	2.7
9/1	3.6
9/1	2.6
9/1	2.5
9/1	9.0
9/6	9.6
9/5	1.65

Total

359

13/1

25

12/3

24

10/6

21

13/2

23

12/5

24

10/7

22

13/3

24

12/6

25

10/4

2

13/6

34

10/5

1

12/6

2

15/1

1

11/3

2

10/1

1

11/4

30

11/1

1

blown off rough
cutting some of edges off rough
cuts.

drilling holes

drilling them

drilling them

Greasing the bolts also putting
plastic bags over threads, full
in 12" holes

Greasing the bolts also putting
plastic bags over threads, full
in 12" holesGreasing the bolts also putting
plastic bags over threads, full
in 12" holesGreasing the bolts also putting
plastic bags over threads, full
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plastic bags over threads, full
in 12" holesGreasing the bolts also putting
plastic bags over threads, full
in 12" holesGreasing the bolts also putting
plastic bags over threads, full
in 12" holes

316

NOVEMBER 11

cline City
Borehole 21 holes
6 hole drill
8k

317

NOVEMBER 12

No 4

Wet

317

NOVEMBER 12

No 4

Wet

REFERENCES

APPENDIX G

References

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9. "Soil Association Map of New York State", by M.G. Cline, New York State College of Agriculture, Cornell University, Ithaca, New York, February, 1963
10. "Orange County Soils. Soil Association Leaflet 2", by E.G. Knox, et al., New York State College of Agriculture, Cornell University, Ithaca, New York, October, 1954